SUBSCRIPTION RATES:

The Annual Subscription, post free, to any part of the world is 21/- (English) or its equivalent in other currency. The price of single copies is 1/6, or 1/9 if sent by post. Back numbers (when available) are charged double if over six months old.

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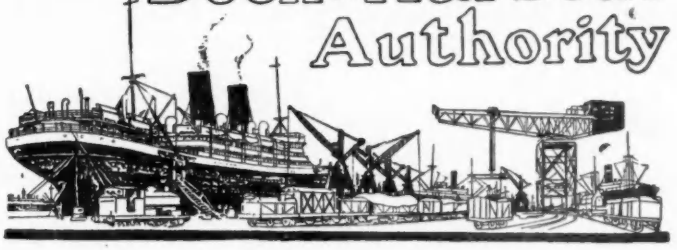

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Editorial Comments

The Port of Aalborg.

Aalborg, a city and seaport of Denmark, it situated on the south bank of the Lim Fiord, about 15 miles from its junction with the Cattegat, and its harbour, which is good and safe, though difficult of access, is with the exception of Copenhagen, the largest in the country. The town is the capital of the district of the same name, and one of the sub-divisions of the province of Jutland. It is one of Denmark's oldest cities and contains a cathedral and a school of navigation; the municipal privileges date from 1342. Commercially, the town is of considerable importance, the chief industries being soap, tobacco, leather and cement manufacture, the latter commodity being exported in large quantities to all parts of the world.

Readers of Mr. Mortensen's very interesting and instructive article upon the modernisation of the port, will be struck with the difficult construction problems presented by the singularly unfavourable foundation strata met with over practically the whole port area.

In all cases of reconstruction work involving reclamation, it was apparently essential to remove the upper layers of soft silt, which was effected by the inexpensive method of pushing it out into the fiord by the deposition of sand, from where it was later dredged away.

The Author's comparison of the several forms of quay wall and their cost is interesting as showing the trend of design of wharves for the type of soil encountered in the port. The special research work carried out by means of the new loading test sampler in respect to the bearing strength of piles will also be noted, and we hope shortly to be able to obtain some further information in regard to the most recent developments of this technique.

The use of screw piles does not appear to have been considered as a possible form of construction in the poor foundation soil of Aalborg. This is a method much used abroad for wharves and bridge foundations in estuarial waters. It is recalled that at Cairnryan similar difficult conditions existed, as shown by the fact that a 14-in. x 14-in. timber test pile, 120-ft. in length with a penetration of 87-ft. failed to give any satisfactory set. Here the Military Jetty or Wharf was constructed of 3-ft. diameter cast iron screw piles some of them having three 8-ft. screws and others two 8-ft. or two 7-ft. screws, each 9-ft. apart. The test loads applied immediately after driving these piles, without causing undue settlement, were 163, 123 and 108 tons respectively.

The approach to Aalborg from the Cattegat is somewhat long, but the only source of much expense is the maintenance dredging of the Hals Bar Channel which is affected by sand deposits, in connection with which it is interesting to observe that the Munch-Petersen formula for littoral drift of sand appears to be completely verified by actual results.

Tidal Model of the River Thames.

The Port of London Authority has announced that a detailed survey of the Thames from Teddington to the Sea, a distance of about 60 miles, has been recently undertaken in order to investigate and study the causes and sources of silt in the river.

For many years the impurity of the Thames has been a matter of concern, enquiries having been held in 1869, 1878 and 1882. More recently, the Authority came to the conclusion that, in addition, the problem of siltation, which involves them in an annual expenditure of several hundred thousand pounds on dredging in the navigation channels and docks, also needed to be investigated.

A siltation committee was therefore formed within the Authority's own executive and technical organisation for the purpose of making preliminary investigations and proposals. As a result, the Board of the Authority decided to construct a tidal model and obtained the collaboration of the Hydraulic Research Organisation of the Department of Scientific and Industrial Research by whom the model will be fabricated in one of the transit sheds of the Royal Docks.

The model will reproduce existing conditions with a view, apart from any special action which may be necessary in respect to pollution problems, to determining what physical measures may be required to overcome the excessive siltation occurring in certain reaches.

The present survey and collection of data for both pollution and siltation studies, which it is expected will take at least two or three years to complete, is being carried out by a staff which includes chemists, hydrographic surveyors and engineers. In this work The Water Pollution Research Laboratory of the D.S. & I.R. is collaborating, and their work on the Tees and Mersey some years before the War, and the methods then developed, will be helpful in the present investigation of the Thames.

A considerable amount of information will be required concerning the land water flow, abstraction of water for drinking purposes, sewerage and trade wastes discharged into the river and tributories, water abstracted and returned by industrial undertakings and generating stations, both as regards solid and chemical content, temperature, etc., and as to the combined effect of all these items upon the condition of the estuary waters.

It is interesting to recall that in 1903 Mr. Cruttwell constructed a model of the Thames, the main object of which was to examine and formulate proposals for the improvement of the navigable channel in Sea Reach, embracing the probable effect of forming the channel by means of training banks. It cannot be said, however, that his results were definitely conclusive, for he appears to have had some difficulty in obtaining the suitably fine bed material which would be transported at the low velocities of his model.

No doubt the model now proposed will be such that it will be capable of solving other conservancy problems with which the Port

Editorial Comments—continued

of London Authority, as conservators of the River Thames, are confronted. For example, the effect of embankment, jetty and bridge construction, land reclamation, coast erosion in the estuary, ballast dredging and the construction of an addition lock and weir between Chelsea and Hammersmith which, it its understood, has been suggested by some navigation interests. Moveover, a conclusion could be arrived at as to the effect upon the regime of the river, of a barrage at Woolwich, the proposals for which were to have been the subject of an enquiry by the Ministry of Transport prior to the War. A detrimental influence if established by the model, coupled with the very great navigational and drainage objections, would effectually condemn the proposal as a practical proposition.

It has always seemed to us that in the River Thames Estuary, similar improvements could be effected as have been carried out on the Tyne and Tees and more recently, in a small way in the Wash. Large areas of land could be reclaimed by judicious training works and embankments, with advantage to the regime of the river, as areas for disposal of dredged material, and eventually as valuable sites for industrial and agricultural development. For the vital point to be kept in mind is not the mere retention of large estuarial water areas, but the preservation of all that part of the tidal river estuary which has a direct influence on the main channel and upper reaches of the river. The new Thames model should solve such a problem without much difficulty, but due regard will also have to be accorded to the special conditions brought about by storm surges in the North Sea and English Channel.

The construction of this model will be watched with interest, and the results and information obtained should prove to be a valuable contribution to the art and the use of scale models in tidal river and estuarial conservancy investigations, and we look forward to the publication in due course of the progress made and the results obtained.

Development of the Port of Dar-es-Salaam.

Plans for the development of Dar-es-Salaam into a major port serving not only Tanganyika, but also the Eastern Congo and possibly Northern Rhodesia, are outlined in a report submitted to the East Africa High Commission by a Committee appointed last December.

The terms of reference of the Committee, which comprised Mr. A. F. Kirby and Mr. W. Urquhart, respectively Superintendent of the Line and Acting Chief Engineer, East African Railways and Harbours, with Mr. A. M. Smith, Port Manager, Dar-es-Salaam, was to consider whether in the light of the physical, geographical and marine features of Dar-es-Salaam, the port is capable of expansion as a major port without excessive and uneconomic expenditure, or alternatively, to what lesser capacity the port is capable of economic expansion. The Committee was also instructed to examine and report whether a port at Msasani would be an economic alternative solution.

The Committee based some of their findings on a scheme prepared in 1929 by Messrs. Coode, Vaughan-Lee, Frank & Gwyther, Consulting Engineers of London, who are now preparing revised plans in the light of the recommendations made in the Report just issued.

The Report recommends improvements to the entrance channel and basin, at a cost of £500,000, and states that as many as 18 deep water berths could be provided if development of traffic should demand them: also the harbour could, at reasonable cost, be made practicable for deep draft ships to leave and enter at any state of the tide. The removal of a sunken floating dock lying just outside the deep channel, which was advocated in the Consulting Engineers' scheme of 1929, mentioned above, is now regarded as imperative.

The port to-day consists of an outer anchorage in Dar-es-Salaam Bay, whence ships proceed through a channel nearly two miles long into a harbour, which is perfectly sheltered by land rising to 40 or 50-ft. The depth of the entrance channel is from 19 to 30-ft., according to the tides, and the area of protected water is 237 acres, which is as large as at many major ports in the world. In the harbour there is room for six deep sea ships of up to 11,000 tons and one coasting steamer, but at present only four berths can accommodate vessels loaded to a draft of over 24-ft. All landing and shipping of cargo is done by lighters at the recently completed lighter wharf.

The land surrounding the Dar-es-Salaam basin and creek is very suitable for the development of port installations and the complimentary rail and road services. A well designed railway marshalling yard layout, serving the port with a double formation track, is already in existence, and warehouse accommodation could easily be increased by reconverting the large hospital building—originally built by the Germans as a port godown—to the use for which it was originally intended.

With the addition of two new berths, the port should be capable of dealing efficiently with a general cargo of about 850,000 tons total a year, which is nearly twice the 1948 total of cargo handled. New deep water wharves are not likely to become practicable for use until the end of 1951, but fortunately the new wharf area is well away from the existing lighterage wharves and it can be served by railway lines and roadways without impeding traffic to and from the existing wharves.

If adequate port facilities can be created at Dar-es-Salaam, the natural and economic outlet for the products from the Kongwa area would be by the existing railway route, and any other route from the Kongwa area to the Port of Mombasa would entail 100 miles more rail haulage than to Dar-es-Salaam.

Recently there has been a great deal of criticism in the press regarding the congestion which has been experienced at the port during the past year or two. One of the reasons suggested is that there has been a deterioration in the labour performance. Years ago, Dar-es-Salaam had a good reputation for the handling of cargo, but it has since been asserted that the previous high standard has not been maintained, especially in regard to stevedoring and cargo handling ashore. It is reassuring to learn that steps have been taken by the East African Railways and Harbours Administration to improve this vital aspect of port working.

With regard to the second part of the Committee's terms of reference, they have reported that construction of a port at Msasani could not be compared with a similar undertaking at Mto Mtwara (now renamed Mikindani), where the port installations are being constructed in almost totally enclosed waters, whereas Msasani Bay is an open bay where breakwaters would be required.

In view of the wide publicity being given to Colonial developments generally, it should be remembered that no definite decisions regarding the proposals for the improvement of Dar-es-Salaam have yet been made. We are informed that the Report of the Committee, referred to above, which has only recently been issued, has not yet been considered by either the East Africa Port Advisory Council, or the East Africa High Commission. When they have done so, they will then submit their recommendations to the Secretary of State.

Extensions at the Port of Takoradi.

Another item of interest concerning Colonial development is the recent announcement of the extension and improvement of Takoradi Harbour in West Africa, which is expected to play an important part in the development of trade in the West African Colonies.

The scheme, which has been prepared by Messrs. Rendel Palmer & Tritton, Consulting Engineers, London, for the Government of the Gold Coast, is estimated to cost £2,250,000 and includes the construction of new timber wharves and the extension of the existing main quay, with new sheds and warehouses. New railway facilities, including running sheds and marshalling yards and 12 miles of railway track, are also to be provided. The existing oil berth and bauxite loading conveyors are to be moved to new positions, and about £230,000 will be spent on new electric cargo cranes. A local land mark, Cox's Fort Hill, is to be removed altogether, and this will entail the excavation of 1,600,000 cu. yds. of soil, which will be used elsewhere for reclamation purposes.

The contractors for the work are the English firm of civil engineering contractors, Messrs. Taylor Woodrow Construction, Ltd., and it is anticipated that the first section of the extensions will be finished in 1950 and the whole work completed two years later.

The Port of Aalborg

Its History and Plans for Future Development

By A. MORTENSEN (Harbour Engineer).

THE ancient Danish city of Aalborg (" the castle on the stream ") is the capital of Northern Jutland and situated some fifteen miles up the Lim Fiord from the entrance at Hals on the east coast, where a sub-aqueous sand bar, Hals Bar, has been formed by littoral sand drift from north and south along the east coast, and the water depth in the fairway has thus been reduced to 12-ft. over the bar against 35-ft. in the fairway on the eastern river-like section of the Lim Fiord.

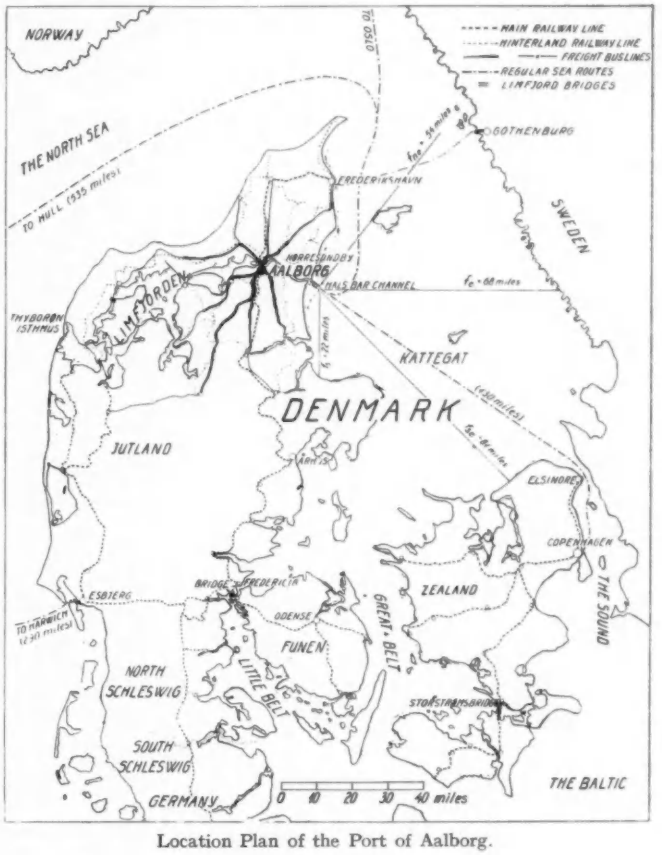
The western lake-like section of the Lim Fiord out to the North Sea consists of deep broads separated from the narrows by similar shallow bars, but at the west coast, the heavy littoral drift—caused by strong western gales—has built up an isthmus connecting the northern insular part of Jutland to the continental part of the peninsula. At intervals of several hundred years this isthmus has been broken through by flood-waves at varying places. The last time was in 1825, but before 1100, it is known that the Vikings were able to gather their armadas behind the protecting isthmus and, using it as their base, they started from here their visits to England and Normandy and returned home with their silver ransom and Danegeld. A great number of English and Arabic silver coins from 900-980 have been found in Aalborg, where from 1035 King Hardecanute established a royal mint, and from the following period a great number of coins with his name and the name of the English mint masters, Lefvine and Alfric from Lincoln, have been found.

The Greek geographer, Ptolemeus, in 130 A.D. gave a description of the peninsula of Jutland, which he called " the cimbric peninsula," but at that time, the northern section of Jutland above the Lim Fiord was parted into three large and a number of smaller islands. During the continued land rise, these islands united to the present island north of the fiord. The first historic account of Aalborg was given in 1070 by a German clergyman, Adam of Bremen, who describes it as " a well-known sea town and a starting port for the sea journey to Norway (1 day) and Iceland (30 days or less)."

Aalborg received its present township privileges in 1342, and from about 1550, information is available about the harbour dues and rules for the use of public wharves. Aalborg was then the largest and richest provincial town in Denmark, second only to Copenhagen, the capital, 130 miles away across the Cattegat. In 1864, the year of the Danish-German war, when Denmark lost Slesvig-Holsten, a pontoon bridge was laid across the fiord between Aalborg and Norresundby (" the town north of the sound "). A few years later a 10-ft. harbour basin, Teglgaards Harbour, was built, and the first Danish long span railway bridge was erected across the fiord in the western harbour section. This bridge, constructed in wrought iron, at the site shown (FIG. 1) was of the typical French latticed girder type but had a unique foundation, which in its design was, for many years, unsurpassed in any part of the world and considered as the limit for compressed air foundations. The water depth at the two central swing spans was only 40-ft., but the bottom consisted of a 60-ft. thick layer of heterogeneous silt increasing to 100-ft. at the shores. The seven brick piers were built on iron-caissons, sunk by screw-jacks suspended in a scaffold, supported by heavy composite bolted timber piles driven down into the silt. One of the piers turned over during the sinking operation, and the air shaft of another blew up, when the air shaft under pressure was loosened from the working chamber roof. Including casualties from diver sickness (3-4 atmospheres pressure) a total of about ten workers were killed before the bridge was opened to traffic.

Thanks to its location at the centre of an extensive hinterland, populated by thrifty farmers, the harbour maintained its position as the most important provincial harbour, until the increasing draft of merchant vessels, about 80 years ago, exceeded the water depth of 10-12-ft. at Hals Bar. This increase in the size of shipping constituted a serious threat to the future development of the port and town.

Fortunately, however, the narrow fairway out to Hals Bar, and the Cattegat outside the bar, is over 30-ft. deep and has only ½-ft. to 1-ft. tidal variation; the old favourable position of the harbour could therefore be restored by dredging a two miles long channel through the sand bar. To this end, a self-loading hopper dredger was purchased in 1883, when also a harbour engineer was appointed. In the following 25 years, the channel was deepened and widened to keep pace with the growing draft of merchant vessels, until finally, the dredger's maximum depth of 24-ft. was reached. Until it was scrapped in 1931, the dredger was only able to maintain the depth of 24-ft. by removing the yearly silt deposit caused by littoral sand drift into the sides of the channel. Since 1931, the channel depth has gradually been increased to 26-ft. by dredging contractors (since 1938 by suction dredger), but unfortunately, the simultaneously established dredger fund was not used in time before the last war for the purchase of a modern dredger and the sharply increased dredger prices have so far impeded the purchase.



Location Plan of the Port of Aalborg.

The Present Port

As soon as the dredging was started, a number of new works and concerns were established at the port, for instance, several cement works (1890), a fertilizer-works, tobacco-, spirit- and textile factories, a ship yard (1917), oil tanks, grain silos, a cattle marketing hall, cold stores, etc. Simultaneously several railways (now eight in number) and a modern road network (now totalling 100 freight

The Port of Aalborg—continued

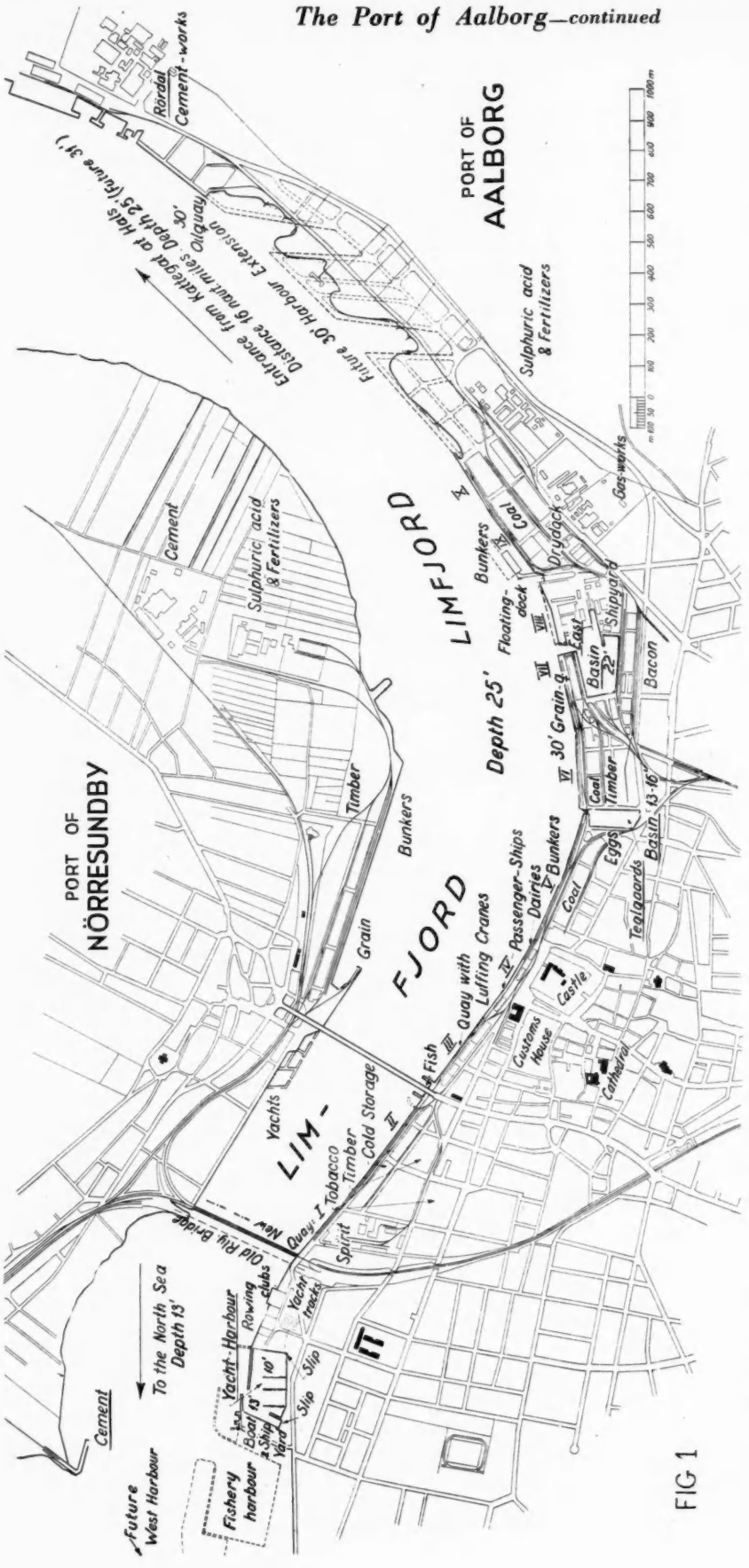


FIG 1

bus and 50 passenger bus lines) were built to link the hinterland more intimately to the port, now consisting of the two municipal harbours, Aalborg and Norre Sundby, and three wharves for the cement-works. Although its economic position has been weakened by being split up into five independent harbours, the port has maintained the lowest rates of provincial harbour dues (averaging 3d. per net register ton and about 1/- per ton of goods except cement), and it may be considered as one port, as the ship dues (per NRT) are paid only once, even when more than one of the five harbours are visited. The fairway in the fiord and over the bar is maintained by a common Fiord Conservancy Commission. Dredging, icebreaking and leading light expenses are distributed between the harbours in proportion to the tonnage of vessels over 300 NRT visiting each harbour. The maintenance is administered by Aalborg harbour, using its dredger (1883-1931), icebreaker (from 1890) and leading light system (from 1894).

The trade of the port has trebled from 1880 to 1914. Between the two world wars the increase was only about 30 per cent. and during the last war the trade was reduced to less than 50 per cent., but by last year, 95 per cent. of the pre-war trade had been regained.

The traffic of the port consists of daily passenger and freight routes to Copenhagen, weekly routes to England and a number of other regular lines of merchant vessels of all sizes. The port was visited by 6,000 vessels last year and of these 5,000 were under 300 NRT, but 110 were over 2,500 NRT, corresponding to 24-ft. draft, which is the maximum draft for a fully-loaded vessel over Hals Bar which at present has a maximum depth of 26-ft. The total inward tonnage is about 1,500,000 NRT.

With 1,000,000 tons imported goods (coal, feeding stuffs, etc.) and 740,000 tons of exported goods (cement, agricultural products, etc.), about 15% of the country's total agricultural imports and exports pass through the port, and as Denmark has a total of four million inhabitants, two million of whom live in agricultural districts, this gives a hinterland of 300,000 persons, besides 100,000 in the town area and 10,000 industrial workers occupied in many works, of which the cement fabrication from chalk of excellent quality in the hills around Aalborg is most important to the port as large quantities are exported in the return loads to the import vessels previously mentioned. There are also other works of importance, as, for instance, a new pig-iron works, two fertilizer works, and a shipyard containing three building slips, capable of accommodating ships of up to 6,000 tons, a 750-tons patent slip, a 350-ft. dry dock and two 1,200-tons floating docks (with pontoon). Also under construction is a floating dock of 8,000 tons capacity.

Port Structures

The sheltered location of the port at a winding in the narrow fiord, renders the use of breakwaters superfluous for vessels over 100 tons. The smaller vessels of the past found shelter at landing-stages in the entrances to small rivers and in small basins, but now these have been closed down and the rivers canalised. Teglgaards Harbour (15 ft.) is the only remaining river entrance, now covered by a short mole and with a railway bascule bridge across the harbour entrance. Eastern Harbour Basin (22-ft.) (see Fig. 1) was built in 1900 and has well preserved plain concrete quay walls, founded in firm glacial clay. The Yacht Harbour Basin, west of the two bridges, was built in 1926

The Port of Aalborg—continued

with reinforced concrete sheet piling in sandy silt. At the western section of the Yacht Harbour (13-ft.) are situated four boat-builders' yards, a ship yard capable of taking vessels of up to 500 tons, a public 175-tons patent slip, etc. The eastern section of the basin (10-ft.) during the yachting season accommodates 250 yachts and motor-boats, which on account of the ice in the winter are taken on land by a 5-ton crane or on a 20-ton patent slip, and the basin is then used for laid-up vessels.

Wharves for merchant vessels are built along both sides of the 1,000-ft. wide fiord, but especially on the southern shore (quay I to X in Fig. 1).

Fig. 2

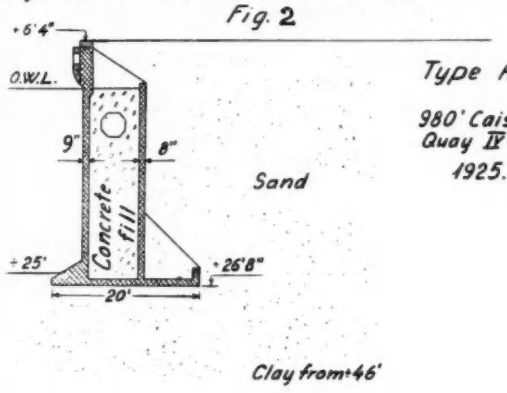


Fig. 3

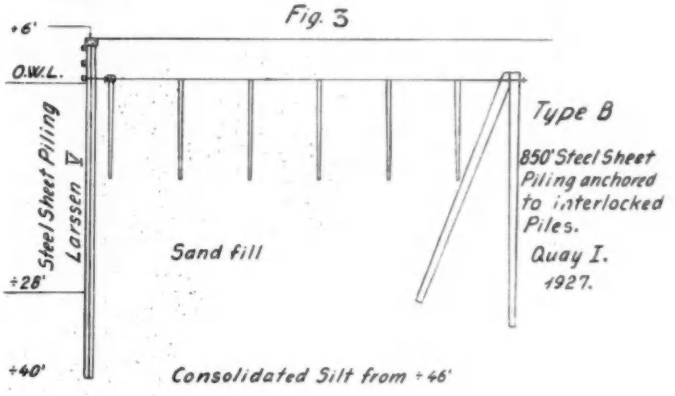


Fig. 4

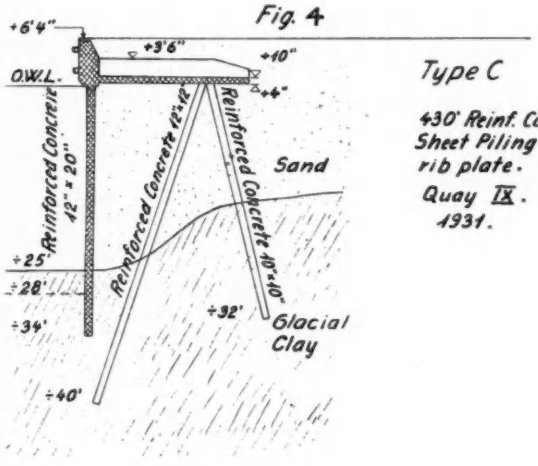


Fig. 5

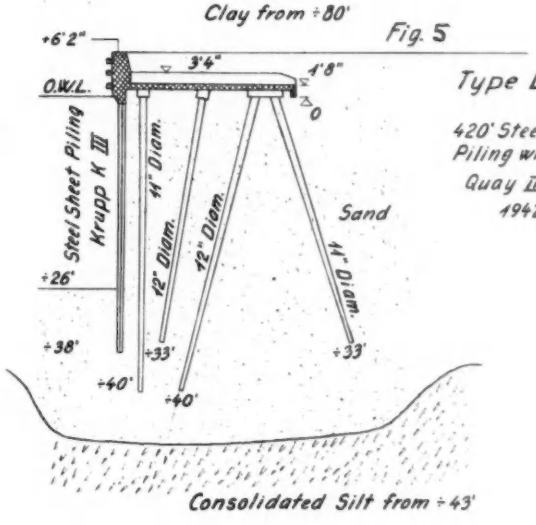


Fig. 6a

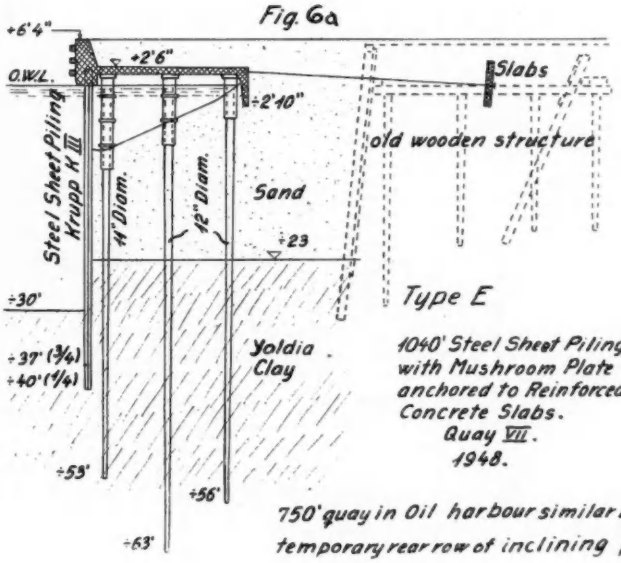
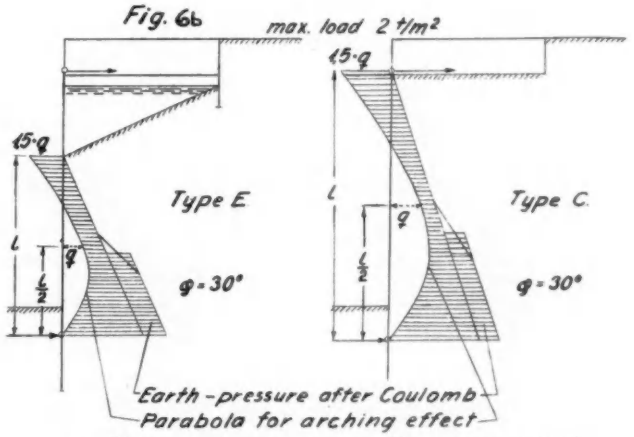


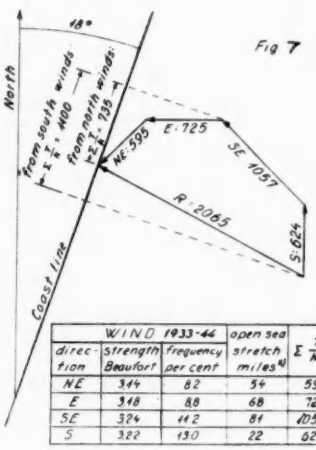
Fig. 6b



$q = K \cdot p_m$, where p_m gives the same moment as the earth-pressure after Coulomb (K approx. 0.9)

Used earth-pressure-curves for the types E and C

The Port of Aalborg—continued



WIND 1933-44			open sea	
direction	Strength Beaufort	frequency per cent	stretch miles*	$\Sigma \frac{r}{R}$
NE	3.44	8.2	54	595
E	3.48	8.8	68	725
SE	3.24	11.2	81	1057
S	3.22	13.0	22	624

* nautical

The advantages of a sheltered location and a rich and extensive hinterland is to some extent balanced by the long fairway with Hals Bar Channel and by poor foundation soil in most parts of the port, where heavy layers of heterogeneous silt and soft clay complicates the foundation of quay walls. This disadvantage was less serious in earlier days, when light wooden jetties and wharves were used by the merchants, but when the excavated channel through Hals Bar had reached a depth of 24-ft., a similar depth was necessary at the quays, and all shore lots inside the city were gradually purchased by the port, which then was able to widen the narrow strip of harbour land area between the old built-up city area and the fiord by moving the quay line out on 24-ft. depth.

Due to the meandering of the fiord, heavy silting has taken place at the convex coast stretches, which includes all the quays, except quay VI to X (FIG. 1) east of Teglgaards Harbour, where the old clay coast on top of chalk is being gradually eroded by wave action. To prevent formation of concave or circular sliding planes in soft silt, caused by the quay structure load, it has been necessary to replace the silt, or at least its upper soft layers, by a sand bank or wall. This has been done in two different ways, depending on the silt consistency: (A) with soft silt layers to a depth of 10-ft. below the future dock bottom, or with soft silt on top of firmer consolidable silt or clay, a sand wall was placed in front of the old quay by a suction dredger through a pipe line gradually elongated in the full quay length, and outside the first sand wall, a new sand wall was placed in the same way until the future quay line was reached; the upper soft silt layers all the time being pushed ahead out into the fiord, from where it was dredged after completion of the quay wall (cost about £15-20 per foot of quay), (B) when the silt in the future quay line was heterogeneous, or the flow of silt barred by obstacles (old bridges, piles, sand walls from neighbour quays, etc.), the silt was dredged to 15-20-ft below the future dock bottom in a 60-100-ft. wide channel below and in front of the new quay structure, and afterwards the channel was filled and subsequently a pipe line was used as under (A) (cost about £30-40 per foot of quay), and (C) a combination of the two methods was used, for instance method (A) for silt between the old and the new quay lines, and method (B) for the new quay proper.

In all cases, where a consolidation of soft lower strata was to be carried out, the top of the sand wall was raised to 15-ft. above the water level extending with a subaqueous slope 1:5 out into the fiord. The quay walls were carried out 2-3 years later, after the sand wall was found to be sinking less than one inch per annum.

Of the port's land area of 325 acres, one half has been reclaimed by the above methods, but Aalborg Harbour, in spite of this widening, still suffers from being too narrow for modern shipping, and the residential buildings are too near the quays to allow of future widening. Furthermore, the 4-5 miles total length of the harbour complicates its administration.

Until 1900 only light wooden quay wall structures were used, i.e., sheet piling or single piles covered on the rear side by horizontal planks and a plank sheet piling towards the backfill (old structure, FIG. 6a) all exposed surfaces being protected by nailing or galvanised sheets. After 1900 only concrete or steel quay walls have been used for the main quays with a depth of 25-30-ft. water, due to marine borers, but the difficult subsoil has necessitated a great variety of wall types (FIGS. 2-6). As a general rule it has been found that caissons and sheet piling of reinforced concrete should be used on firm subsoil only, that is, on glacial clay, and when the backfill is clayey. When sheet piling is driven in shallow water or through 40-50-ft. thickness of sand, the necessary tightness is attained only by steel sheet piling. Where considerable settling takes place as, for example, on plastic Yoldia clay or on soft silt layers below the sand wall, the types C, D and E with a horizontal plate are preferred, and especially type E, by which the pile loads from the superstructure are more uniformly distributed on the subsoil and the settling further decreased by omitting earthfill between the vertical heel plate and the steel sheet piling, which also relieves a great portion of the earth pressure (FIG. 6b) and thereby reduces the wall thickness. As serious corrosion only takes place at a depth of 5-7 ft. below water, after lowering the water level correspondingly for permitting a general inspection, the steel sheet piling may afterwards be strengthened by welding or concreting on the rear side. In tidal basins the difference in water level may be equalized by a number of subaqueous holes with plugs. Every fourth pile is, as a safety measure against scour from eddies, driven 3-5-ft. farther down than the rest of the wall, which also gives an extra dredging margin.

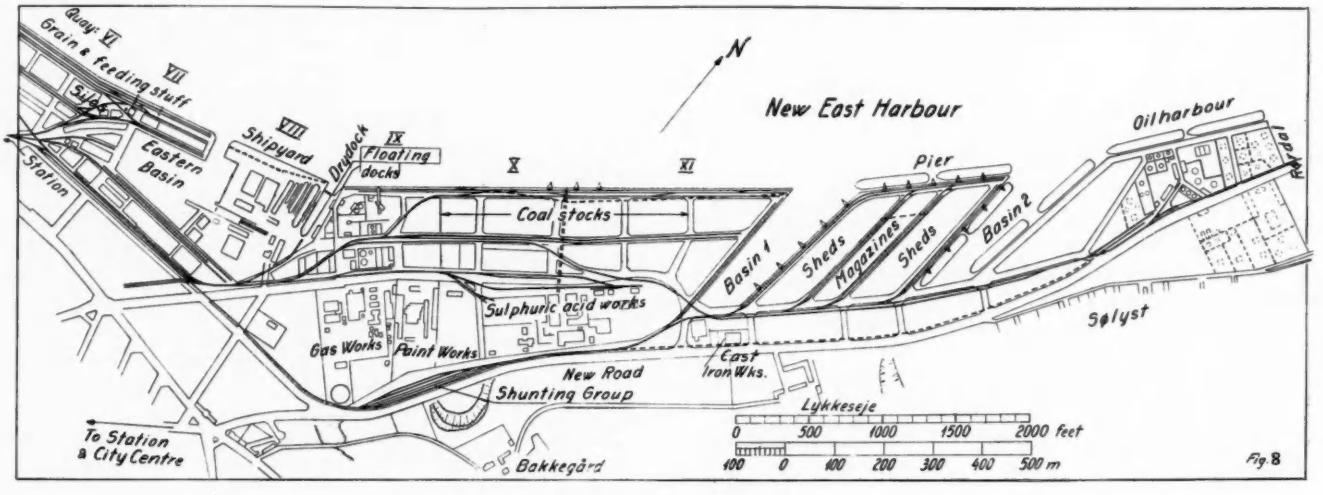


Fig. 8. Development plan : Eastern Extension.

The Port of Aalborg—continued

Quay Wall Types in Aalborg Harbour

Type	Fig. No.	Description	Average cost per lin. ft. of quay.* £		Use
			Depth		
			25 ft.	30 ft.	
A	2	Slender concrete caissons (plain concrete fill.)	55-60	85-90	On firm soil, not on shallow water.
B	3	Steel or concrete sheet piling, anchored to interlocked piles.	50	70	On smaller depths.
C	4	Reinforced concrete sheet piling, horizontal rib plate and piles, inclining 1:3.	45	65	Clay bottom and backfill, high maintenance cost in sand wall.
D	5	Steel sheet piling, concrete rib plate on wooden piles. 1:3	42	60	Preferred under ordinary conditions.
E	6	Steel sheet piling, concrete mushroom plate and heel plate on vertical wooden piles, anchored to a vertical slab. Subaqueous slope between sheet piling and heel plate	35	50	Preferred on soft and settling subsoil.

*Excluding earth-work and quay-roads, 1948 prices.

Older quay roads were paved, and later asphalt was used over the tracks, but the latest development has been the use of asphalt all over the quay roads, except at the quays for general cargo and passenger route vessels, where the heavy traffic of iron clad wheels (handcarts) necessitates the use of reinforced hard concrete slabs, resting on the sleepers.

The total quay length of the port is 8,500 yards, of which 2,000 yards is in basins for small vessels. Of this total length now only 10 per cent. are old wooden structures (due to marine borers), 65 per cent. have walls or sheet piling of reinforced concrete and 25 per cent. have steel sheet piling, which now is preferred by Aalborg Harbour on greater depths. The length of harbour tracks is 18 miles and of harbour roads 15 miles. There are 18 cranes (5 public) and 6 grain elevators, the floor space of private warehouses is 800,000 sq. ft., of the cattle marketing hall 100,000 sq. ft., capacity of oil tanks 35,000 tons and of grain silos 25,000 tons.

Since *The Dock and Harbour Authority*, in October 1927, published a plan of the harbour, the pontoon bridge has been replaced by a 7-span plate girder bridge and the old railway bridge by an 8-span single track bridge with double and single leaved bascule spans, respectively. Both bridges have reinforced concrete piers down to the bottom (silt, locally replaced by sand) and are resting on tubular concrete piles, driven by a subaqueous pile driver till the top was 5-ft. above the bottom. Afterwards the piles and working chambers were filled with concrete. The longest pile was 150-ft. and the point was 170-ft. below water.

Planning of Port Development

The idle years during the German occupation were used by the engineering staff to make a thorough survey of the future possibilities and development of the port in order to obtain an idea of the necessary future programme of development for relieving the most urgent needs of the port, such as increased depth, establishment of a reserve of quays and quay plots, rearrangement of berths and areas according to size of vessels and goods to be dealt with at them (coal, oil, grain, timber, etc.), an industrial area with possible Free Port, purchase of a larger icebreaker and a number of cranes, etc.

A traffic and trade forecast for the coming 50-70 years, corresponding to the life of quay wall structures, is complicated by the possibilities of changes in the hinterland (new ports, competition from neighbouring ports, the development of the means of transport etc.) but it is found reasonable to assume that the extension of the hinterland may be slightly increased due to the use of larger and faster motor-lorries, as already now taking place in the petrol distribution to Jutland from a northern depot (in Aalborg) and a southern depot (in Fredericia). The pre-war petrol import of 60,000 tons has already been doubled, and the present letting contracts of plots in the new oil harbour (at the eastern city frontier

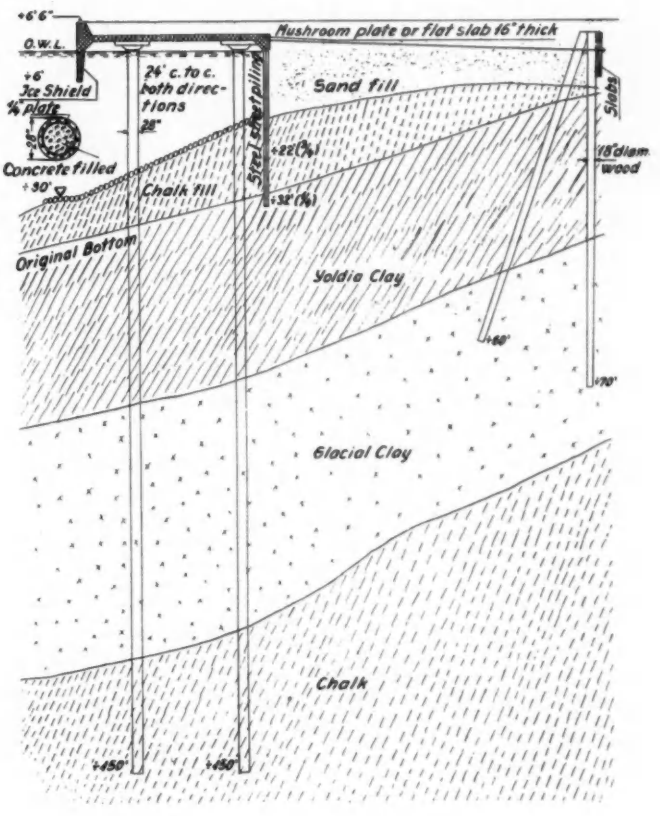


Fig. 9. Proposed Quay Wall on Yielding Subsoil.

to Rordal Cement works) provides a tank capacity of 150,000 tons, and in view of the probability of the transition to oil fuel in industry and of mechanized farming an import of 500,000 tons of oil and a slight decrease of the coal import, 450,000 tons, may be assumed.

With the present birth-rate the town population is assumed to be increasing by 65 per cent. to 170,000, while the farming hinterland population only is increasing by 33 per cent. to 400,000 persons, but increasing rationalization and mechanization of farming, cultivation of poor soil, etc., will require more fertilizers per person, and more intensive farming and increased live stock will require an increased feeding stuff import for which reasons both the agricultural import and export it is assumed will be doubled. Also the import of consumer goods for the town and hinterland population are assumed to be doubled due to increase both in population and in living-standard. The industrial import and export is more difficult to foresee, but beside the same 100 per cent. increase as above, due to increase in population and living standard, a 50 per cent. margin is given for entirely new industries, for example, salt (from new deep borings), new products of chalk (soda), cement (asbestos-cement), etc. Two modern fast freight and passenger vessels for the daily route on Copenhagen are now under construction and will call twice daily, which alone raises the NRT for Aalborg Harbour by about 500,000 NRT to 3,500,000 NRT.

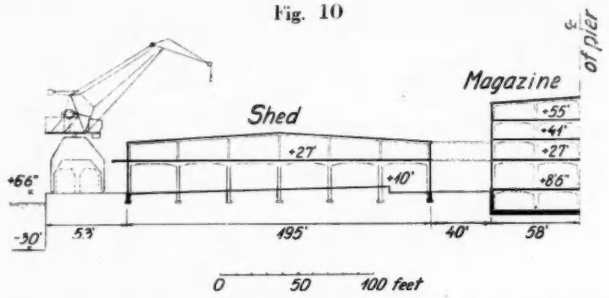
An estimate of the necessary depth in the fairway and in the Hals Bar Channel involves a prognostication of future ship building development, which only is possible by studying the development up to the present time and afterwards giving a margin for the uncertainties of the future.

The Swedish Harbour Association in 1943 established that the draft of transocean going vessels should be assumed to be 28-ft., for ocean-going tankers 29½-ft. (with the channel depth 2-ft. more), which is the same as assumed in Bruxelles 1935, so that stabilisation seems to have been established.

A record of the number and nett registered tonnage of vessels calling at the Port was kept, the dimensions of the calling vessels

The Port of Aalborg—continued

Fig. 10



were plotted and average curves for width, draft and length of vessels drawn. It was noted that the number of vessels over 2,500 NRT (24-ft. average draft), unable to pass the bar fully loaded, has since 1938 increased from 64 to 111, but their NRT increased from 240,000 NRT (17 per cent.) to 430,000 NRT (30 per cent., of which two-thirds are Scandinavian vessels) with 350,000 tons goods.

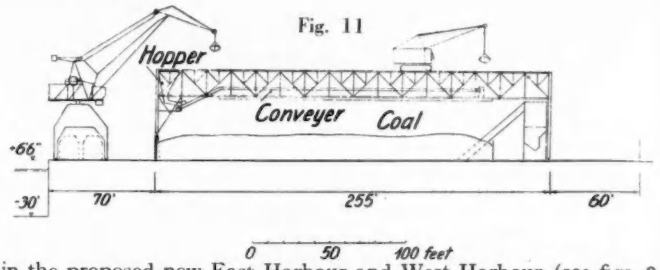
Investigations call for a channel depth of not less than 31-ft., and in the fiord this depth may be achieved by only altering the location of leading lights. In Hals Bar Channel (2 miles) and its 2 miles extension, about 800,000 cub. yards of clayey sand is to be dredged with the present channel width. 200-ft., but a total of 1,600,000 cu. yds. when the width is increased to 300-ft., in which case the total cost is estimated to £350,000, against £800,000 for 34-ft. depth.

As to the possibility of an increase in the yearly maintenance costs in a channel deeper than at present, it is found that the present yearly deposit is in agreement with the formula for littoral drift by the late Professor Munch-Petersen (Copenhagen), according to which the sand transporting force, T, for winds from a direction ϕ is determined by $T = k \Sigma (hS^2 \sqrt{f \cos \phi} \Delta \phi)$, where k is a coefficient for grain size, etc., h and S the wind frequency in per cent. and the average strength in the Beaufort scale, respectively, f the open sea stretch in miles, all in that direction ϕ (NE, E, etc.), the angle ϕ being measured from the coast line. In fig. 7 the forces $\frac{T}{k}$ for Hals Bar, from 10 years' meteorological observations (see table fig. 7), are projected upon the coast line, and the sand carrying forces parallel to the coast line are found on an average to be $\Sigma \frac{T}{k} = 1100$ from south and 735 from north, respectively. The yearly average total deposit was $Q_n + Q_s = 50{,}000$ cu. yds. $= 27 \Sigma \frac{T}{k}$. The yearly deposit, dredged in the two sides of the channel 1933-1943, also are in agreement with the formulas: $Q_n = 27 \cdot 735 = 20{,}000$ cu. yds. and $Q_s = 27 \cdot 1100 = 30{,}000$ cu. yds. and also all later deposits have been concordant with the formula $Q = 27 \Sigma \frac{T}{k}$ (when icebound f = O). This seems to indicate that the sand currents both from N and S are totally trapped in the channel, and as deposit of silt from the sandfree fiord current is neglible no increase of deposit in the present channel length is to be expected.

The 2 miles elongation of the 31-ft. channel out in Cattegat is located on 26-ft. depth and over, where no littoral drift has been found, and the present silting deposit, 50,000 cu. yds. per annum, may be assumed increasing to about 70,000 cu. yds., mainly due to possible deep sea currents in the eastern channel elongation. The yearly interest expenses on the deepening and widening loan plus the yearly maintenance cost for the 31-ft. channel is estimated to be £35,000 against £15,000 at present, and to be £70,000 for a 34-ft. channel and fairway. The additional yearly cost of a 31-ft. channel, £20,000, is balanced by the extra freight charge on ships calling at two or more ports, about 3/- per ton for 200,000 tons of goods (petrol), or about £30,000 per annum.

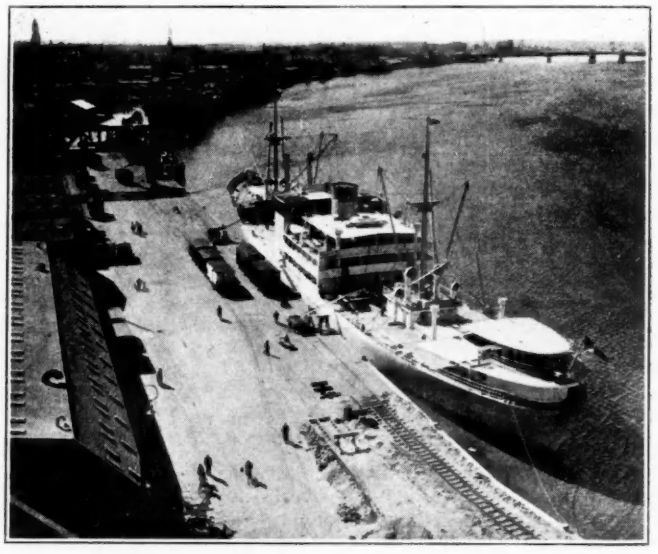
A geotechnical survey of the harbour extension and quay areas

Fig. 11



in the proposed new East Harbour and West Harbour (see figs. 8 and 12) has been carried out with a new loading test sampler, described in " Proceedings of the Second International Conference on Soil Mechanics, Rotterdam, 1948," vol. 1, sect. IIIa, 1, and vol. II, sect. VIIa, 2. The point resistance $\frac{\pi d^2}{4} \sigma_V$ and the friction π d h t were found by test loading and extraction of the sampler, whose diameter was d and length h.

From shear tests and model pile tests upon extracted soil samples the shear strength v of the soil was found, and the safe vertical soil pressure σ_V. The values of σ_V and t found by both methods at different depths are used in the formula for determination of the pile resistance, P, of a few cylindrical test piles with diameter D: $P = \alpha \pi \Sigma (D\ t \triangle h) + \beta \frac{\pi D^2}{4} \sigma_V$, where $\triangle$ h is the layer thickness covered by a sample test. The transition coefficients from sampler to pile, α and β, are found from full size pile loading and extraction tests near typical borings.



Aerial View of Quay VI and VII, Aalborg Harbour.

The bottom in the new East Harbour consists of a 50 to 60-ft. layer of plastic Yoldia clay on top of glacial clay and chalk. If direct foundation in Yoldia clay were used, the walls or caissons were estimated to settle about 2-ft. according to compression tests, whereas pile foundation in the future Quay XI, in continuation of the present Quay X (fig. 1), requires a 120-ft. pile length.

But if the quay line for Quay IX is to be elongated towards the east (fig. 8). thus eliminating the two existing bends, a pile length of 150 to 160-ft. is necessary at the eastern part of Quay XI. Here a new quay wall type is proposed (fig. 9), consisting of a horizontal flat plate resting on vertical 28-in. diameter hollow reinforced concrete piles, spaced about 24-ft. in both directions and anchored to a vertical concrete slab on piles 70-ft. behind the plate. The backfill is confined by a steel sheet piled wall suspended from the plate close to the rear pile row to counteract the difference in settlement of the plate and the steel sheet piling, the latter settling more rapidly than the deep pile foundation.

The Port of Aalborg—continued

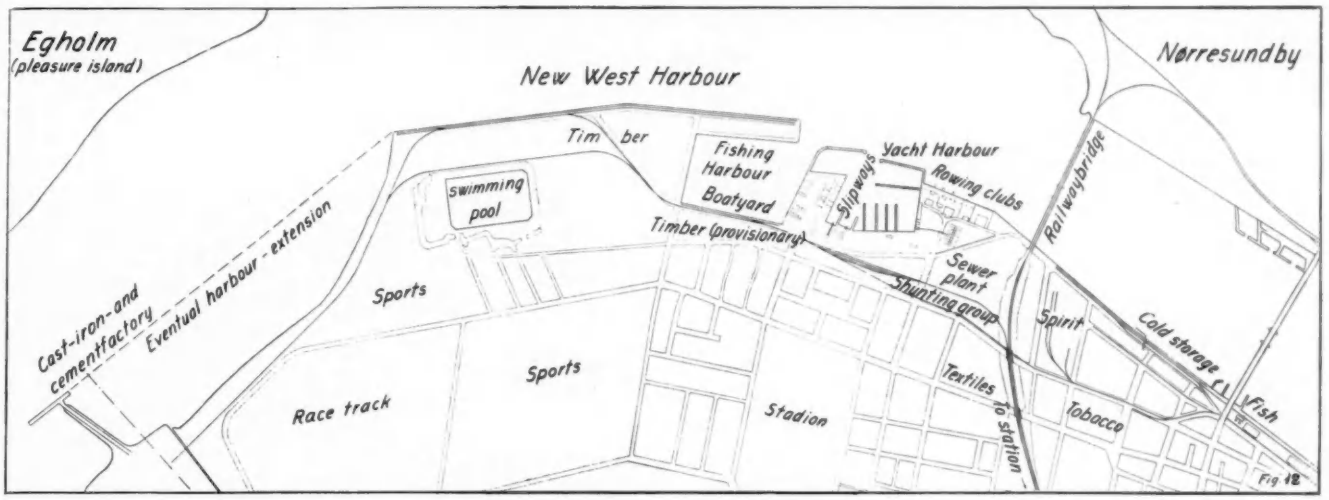


Fig. 12. Development plan : Western Extension.

In the western harbour extension (fig. 12), the bottom of the fiord on the quay line, to a depth of 100-ft., consists of layers of soft silt with downwards increasing contents of sand, and the upper 50-ft. of silt must be replaced by sand before the quays (type E, fig. 6) and moles are built.

Port Development Plan

Aalborg Harbour.

The first and most decisive step to be taken is the dredging of the Hals Bar Channel to 31-ft. depth, and next the widening to 300-ft.

All main quays are to be placed east of the bridges on 30-ft. depth for oil tankers, grain vessels, etc., and with the longest possible stretches of straight quays for improved utilisation of quays and cranes.

The Free Port, with four basins, described in the *Dock and Harbour Authority*, October 1927, has been abandoned due to altered political and commercial conditions in the Baltic, for example the present extensive use of bonded warehouses, etc. A new plan, with two basins only (FIG. 8) has therefore been decided upon, giving greater pier areas rather than more quay length. To cope with the present rapid development of the petrol and oil imports the oil harbour has been increased to 30 acres, and the remainder of the eastern port extension area is to be used for a new commercial Eastern Harbour with two 30-ft. basins (average width 300-ft., length 1,100-ft.) and a 1,000-ft. wide pier at an angle of 45° to the fairway with sheds and magazines. The sheds are to be served by a considerable number of level luffing port cranes (FIG. 10) similar to those in use in Gothenburg and the Free Port of Copenhagen.

The present quay X and the future quay XI (FIG. 8) will be moved 60-ft. out in elongation of quay IX thus giving 3,100-ft. of straight quay, of which the western 600-ft. (quay IX) is taken over by the ship yard as a back area for the dry dock and the three new floating docks.

After removing all petrol tanks to the oil harbour, quay X and XI will be transformed into a main coal quay, served by public level luffing quay cranes, delivering the coal, etc., through private conveyor bridges to the stocking areas, gas works and fertilizer works. (FIG. 11).

Quay VIII (ship yard) this summer will be moved 15-ft. out at the eastern end and 65-ft. at the western end to give place for rails for a new 45 ton level luffing crane.

Quay VI and VII have just been rebuilt to 30-ft. depth and are reserved for the grain and feeding stuff traffic. Two modern elevators of the Swiss Redler-System are under construction, and the present timber stock is transferred to the west side of the New Fishing Harbour.

It is proposed to reduce Teglgaards Harbour to four times the width (30-ft.) of the opening bridge to give place for a fuel stock west of the basin for the municipal electricity works at the south end.

Quays III, IV and V are reserved for the regular passenger and general cargo lines, and the present six cranes are increased by four level luffing cranes.

Quays I and II are for neighbouring large tobacco-, textile-, spirit and soda-works and the three-storey cold store building (now increased to six storeys).

West of the railway bridge (FIG. 12) an area is reserved for a sewer separation plant. Between this and the Yacht Harbour are placed four rowing clubs, a canoe club and rails for the yachts laid up on land in the winter.

The Yacht Harbour will be extended later to the north by building two new outer moles, but until then one of the three yachting clubs may be transferred to the north mole of the new Fishing Harbour (under construction), the western quay of which is to be used for fishing vessels and its southern quay for the timber trade (18-ft. depth), which makes it possible here to gather together the timber yards now spread over the port. Later the area between the Fishing Harbour and the municipal swimming pool (during the war used as a German hydroplane base) is to be reclaimed, using the earth fill covering three German concrete bunkers. All the timber traffic then will be transferred to the future timber quay towards the fiord in front of the reclaimed area, and the Fishing Harbour may then be reserved for larger vessels laid up at the centre of the basin and for vessels in the Lim Fiord traffic.

After the above extensions have been completed, the total quay length will be increased by 100 per cent., but by improved quay utilisation (cranes, etc.) the harbour will be able to take a 150 per cent. increase of the NRT.

As a future harbour extension reserve there remains only the one mile stretch of coast west of the swimming pool, this area is now provisionally utilized as a sporting section (swimming, race-tracks, football grounds, etc.). The western section of this area, adjoining the Cement-Iron works, may be used for clean industries, but generally industries connected to the harbour will be placed at the north and eastern side of the fiord bend at Rordal Cement Works, one mile from the oil harbour and two miles from the city centre, connected by rails to both. Here also is a very suitable location for a later free port.

Rail connections to the main station may be improved by adding a third track to the main line from the bridge (FIG. 12) to the station to be used for goods from the western section of the port, the eastern being served by the present single track connection line from Teglgaards Harbour. Two areas are reserved for harbour shunting groups for the eastern and western section.

The Port of Aalborg—continued

Aalborg Harbour now has 225 acres of land areas, of which one-third is road and rail and one-third harbour areas and one-third unused land reserves, but through the above described development a further 125 acres are reclaimed, giving a total reserve of 200 acres or 133 per cent., besides the proposed industrial area, north-east of Rordal Cement Works, of about 500 acres.

Norresundby Harbour and the three Cement works are also able to increase their quay length in accordance with the traffic, and their harbour land areas, about 100 acres, may be increased as necessary.

Conclusions

It has now been shown that sufficient quay and land reserves are available for the trade and traffic that may be expected in the next 50-70 years, but considerable expense is involved in the development plan, for example £150,000 for a new dredger and a new icebreaker, £350,000 for the dredging of Hals Bar Channel to 31-ft., £700,000 for the new Eastern Harbour, £100,000 for the Fishing Harbour, £300,000 for the Western Harbour and £200,000 for cranes, etc. Including reclamation of the industrial land areas this gives a total cost of over £2,000,000. The influence of future transport methods and means of propulsion (air transport, atomic energy, etc.) it is impossible to foresee and also the trade and traffic prognostication is impeded by several uncertainties. It is essential, therefore, that the development plan should be elastic and preferably carried out in step with the growth of trade. Likewise the details should be flexible as, for instance, the use of wide basins, long stretches of straight quay, quay walls of steel sheet piling sufficiently long for a later increase of depth of water, widening the horizontal plate, relief of earth load under the plate, etc.

But notwithstanding the necessity for a certain degree of prudence, an energetic initial effort is required to ensure that the port may regain its natural position, and that in the future it may be used by large vessels as first port of call upon arrival in Danish waters and that the ocean-going vessels may take full return loads of cement before leaving the last Scandinavian deep water port. The first step in this direction has been taken by building two deep-water quays (30-ft. in the oil harbour and at the grain quay) and the deepening of Hals Bar Channel to 31-ft. which is to take place during the next few years.

View of Quay III taken from road bridge.

Correspondence

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,—

Tidal Models

I welcome that part of Prof. Allen's letter in your July issue which gives quantitative arguments. I accept that the frictional coefficient in the model must be considered as greater than that in the estuary, and in fact my own conclusion, as given in notes sent to interested parties some time ago, was that the model might be taken as having a frictional coefficient as much as 6 times greater than in nature, so that apparently a distortion of 6 : 1 would be permissible. Prof. Allen's figures would seem to suggest that 3 : 1 is appropriate for stationary grains and about 25 : 1 for a general movement which produces ridges in the bed. If these ridges are also produced in nature then such a large distortion in the model would be necessary, but in general it would appear that a vertical distortion of about 6 : 1 would be permissible.

As Prof. Allen says, there is, however, still a great deal to be explained when vertical distortions of the order of 40 : 1 are employed, and his comments imply that with such large distortions artificial roughening is necessary, and this cannot be popular with those who are interested in silt movements. In cases where this has not been employed, stress is laid on the formation of eddies in the model as the main source of frictional losses. If three models with large distortions of scale agree approximately among themselves it just proves that in each the artificial eddies are predominately the source of the frictional resistance. **But if these artificial eddies are not in the natural estuary** then the theory of the model is vitiated. I am combating the idea that it does not matter how the frictional resistance is obtained so long as there is an " over all " agreement, for this is the argument of the fair-ground proprietor, that what he loses on the swings he gains on the roundabouts. In this matter if we introduce " roundabouts " in the model to compensate for the deficiences of bed friction we immediately destroy the similarity with nature, and the indications of the model may be misleading.

I am deliberately refraining from replying to the many misleading statements made by Prof. Allen with regard to Sir Geoffrey's investigation and to bores, because the main issue is, What is a reasonable or permissible distortion of scale **in a model covering a large estuary?** My conclusion is that I would accept 6 : 1.

Yours faithfully,

A. T. DOODSON.

Liverpool Observatory,
and Tidal Institute.
22nd July, 1949.

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,—

Tidal Models

The correspondence on this subject in your columns by Prof. Jack Allen and Dr. Doodson indicates the importance which the matter has assumed among harbour engineering specialists, especially in view of the experimental enquiry into the effect of a dam across the Severn Estuary. The mathematical researches of the writers are of undoubted value to all those engaged in this field of investigation and it is without the least desire to depreciate the results of their careful and painstaking calculations that I venture to suggest the possibility of over-rating the validity and reliability of the results. Reduced scalar models of tidal action in estuaries, and particularly where there is appreciable distortion between the horizontal and vertical scales cannot escape the reflection that there is room for misinterpretation of conclusions based on minute adjustments, such as are inevitable from the nature of the case.

I cannot claim any actual experience in estuary model construction, but during the time that I was Lecturer on Waterways, Harbours and Docks at University College, London, where the Rangoon Estuary Model was in course of construction and working under the skilful and competent direction of Mr. Oscar Elsden on behalf of Messrs. Sir Alexander Gibb and Partners, I had numerous opportunities of inspecting the model and discussing its progress with him and I felt that there were undoubted possibilities of variation and error which might partially, at any rate, vitiate the results, however carefully deduced. Indeed, from my acquaintance with the Estuary of the Mersey, I know what important consequences can follow from slight deviations in the banks, as in one well-known

Correspondence—continued

instance when the mere grounding of a derelict barge on one side of the estuary resulted in the deflection and meandering of the navigable channel right across the entire width (some 2½ to 3 miles) of the estuary. If such an incident could occur in a natural waterway, how great are the chances of channel misrepresentation in a scalar model of much reduced size.

While freely admitting the utility of the indications of a general trend to be observed in such investigations, I feel it is desirable to treat them with some reserve as regards details.

Yours faithfully,
BRYSSON CUNNINGHAM.

Eastbourne.
July 20th, 1949.

To the Editor of *The Dock and Harbour Authority*.

Sir,

Canals and Inland Waterways

Although steadfastly opposed to the principle of nationalisation, I nevertheless fully recognise the advantages of unification of control and see the prospect of Capital improvement schemes which are now possible under State ownership.

The D. & I.W.E. deserve, in my opinion, encouragement rather than criticism, seeing that they have only been in the saddle for eighteen months. I would, however, mention two points:—

(a) There is still too much centralised control from Dorset square; this, amongst other things, has the inevitable effect of spreading frustration and apathy among the staff in the Divisions (taking some part in the management of two canal undertakings before nationalisation, I am perhaps in a fair position to observe staff reactions before and after).

(b) The lack of, or their delay in launching a national canal publicity campaign.

Regarding (b), and so far as the canal carriers are concerned, it is the opinion of some canal carriers that intelligent canvassing generally brings more traffic than advertising, although this does not take away from my opinion that the canal system as a whole should be publicised.

Whilst on the subject of publicity the activities of the recently-formed Inland Waterways Association should be mentioned, although they are not always helpful to the industry. Mr. Aickman says in his letter in your July issue " the relevant trade associations, such as they are, are concerned only to secure for their members (mostly trading in a single small area) a quota, the steady diminution of which they make no attempt to resist. To advocate a policy of expansion in certain influential trade circles is notoriously to court expulsion." This, of course, is just stupid nonsense and is not worthy of comment; statements such as these make me wish they would confine their enthusiasm to " roses and castles " and the Basingstoke Canal. I am opposed to the general view they seem to take up that a canal with a picturesque background rather than a commercial future should be kept open, as this must inevitably direct money away from those canals on which there is traffic and which would attract more traffic if improvements were made.

Geographical conditions in England impose physical limitations not experienced on the Continent, but there is no doubt that the larger canals, with direct access, or through navigable rivers, to the principal estuaries, are playing and will continue to play a useful part in the transport system of this country. Their part can, I feel, be increased when the various schemes of improvement in size of locks, draft, headroom and general facilities, are suggested by the Carriers and Traders and known to the D. & I.W.E., are put into operation. Larger craft mean cheaper operating cost.

You make mention, Sir, in your June Editorial, of the problem of widths of existing locks. You have, in my opinion, put your finger on the very heart of the problem with regard to the many miles of narrow canals. Having had experience in the operating costs of narrow boats, I find it hard to see how, apart from some notable exceptions covering specialised trades, they can compete with modern road haulage unless they are to rely on artificial rate protection and toll subsidies. Their earning power on present freights is insufficient to justify new construction at present prices; their living accommodation, owing to their size, is too meagre to attract new recruits (labour, it might surprise Mr. Aickman, is not " in full flight " from the 100-ton size vessel and upwards, as pay is reasonable and accommodation rapidly improving). I believe that sooner or later certain selected narrow canals, on which there should be a natural trade flow, must be re-constructed to allow the passage of vessels carrying at least 100 tons.

Yours faithfully,
G. L. LYON.

Harker House,
Knottingley, Yorks.
18th July, 1949.

Book Reviews

Annales des Travaux Publics, Belgique. Numero Jubilaire, 1843-1948 (Records of Public Works, Belgium. Jubilee Number, 1843-1948), 213 pp., Brussels.

This very handsome issue of "Annales des Travaux Publics" celebrates the centenary of that publication and gives a general view of the progress of public works in Belgium during the period since the founding of the journal in 1843.

To the readers of the " Dock and Harbour Authority," interest will principally be found in the section entitled " A century of activity of the ' Bridges and Highways Administration ' in the realm of waterways " (pp. 39-63, followed by a four page summary in Flemish).

This opens with a statement of the network of navigable routes which existed at the date of Belgium's coming to independence, preceded by some very interesting historical notes on the developments of waterways in relation to Ghent and Bruges since the twelfth century. Next follows an account of the development of waterways up to 1914, and then the more recent developments. A description is then given of dammed reservoirs. The ports (Antwerp, Ghent, Zeebrugge-Bruges and Ostend) are then discussed, and finally the hydraulic laboratory of the Ministry of Public Works. It is rather striking that the laboratory should be regarded as the culminating feature of the hydraulic work in Belgium and provides good evidence of the importance which is attached to model investigations of proposed works.

The general situation is clearly indicated by a map on page 53. By way of Antwerp, vessels up to 2,000 tons can reach Dendermonde, Brussels and up the Meuse beyond Liege. Similar vessels can reach Bruges from Ostend or Zeebrugge, and can reach Ghent from the lower Scheldt. Vessels of about 1,000 tons can pass from Ghent to Bruges, go right up the Meuse via Namur into France and attain most points within north-eastern Belgium. Thus a very large part of the country is accessible to barges of great capacity. Extensions are projected which will permit vessels of 600 to 1,350 tons to reach Tournai and Charleroi.

A very full description is given of the reparation of war damage which has enabled almost all the canal network to be re-opened to traffic. The Albert Canal (from Antwerp to Liege) in December, 1945, still required some locks to be repaired.

The various articles are well and fully illustrated.

Some of the other parts of this issue have indirect interest. Thus on p. 87, the soil mechanics laboratory in Brussels is described. There is quite a considerable amount of information on structural mechanics (e.g., pre-stressed concrete), an historical study of strength of materials, etc. Altogether a most valuable production.

The Ports of the United Kingdom, by Sir David J. Owen, 378 pp. with numerous monocrome illustrations. Published by Allman & Son, Ltd., London. Price 30/- nett.

It is significant of the accelerating speed of modern times that most text books are now out of date far soon than those published in more leisurely days. When THE PORTS OF THE UNITED KINGDOM was first published in 1939, few of the readers who welcomed it as the most useful survey of U.K. ports yet produced realised that six years of war followed by four years of intensive legislation would combine to render it incorrect in a number of details. The revised edition now issued has brought

Book Reviews—continued

the information into line with the Transport Act, 1947. The complexities of overseas trade, in which British ports play such an important part, do not grow less, and all students of transport will welcome what is virtually a key to an otherwise bewildering pattern of port administration and operation.

A technical description of each port is preceded by a fascinating thumb-nail sketch of its history and development from the earliest times; the author, past President of the Institute of Transport and late General Manager of the Port of London Authority, was recognised until his death in 1941 as one of our foremost authorities on port administration, but he deserves almost equal recognition as a historian, for much painstaking research has gone to the making of this book. It is a reflection of the present-day international importance of the British shipping industry to find that, although geographical factors and local industries have combined to give birth to our ports, the rise or fall in their individual status has often been engendered by overseas events outside the control of us islanders.

Port administration differs perhaps more widely than in any other industry of comparable size and importance. We learn from this book how London Port is governed by a representative authority similar in most respects to the older authority administering the Port of Liverpool. The Port of Bristol, on the other hand, is governed by the municipal authorities, and Southampton, formerly owned by the Southern Railway Company, is now (nominally, as yet) administered by the Docks and Inland Waterways Executive of the British Transport Commission. Port operation differs almost as widely as administration, and the pattern of dock construction, maintenance, pilotage, loading and discharge of ships, warehousing and other services ancillary to port operation is an excellent example of the British genius for independent control skilfully blended with the compromise engendered by local experience.

It is not perhaps the major and well-known ports which provide the greatest interest in this book so much as those fascinating little harbours which most of us know only as holiday resorts without realising that they often carry on an extensive coasting and sometimes an overseas trade. I venture to suggest that some of the minor ports described by the author are completely unknown outside the coasting trades and the special local industries which they serve. It is in these local industries that the author so often traces the beginnings of a port, for large-scale international trade is a comparatively recent phenomenon, and it was invariably the desire of the local man to make his lot easier by seizing upon the advantages of water transport that first inspired him to improve the existing natural harbourage.

The illustrations are well chosen and add to the value of a book which should be read not only by students of transport and its allied industries but by all who realise the importance of the part played by docks and harbours in our present struggle.

Port of London, 1949, by Frank C. Bowen, 216 pp. with illustrations and coloured maps. Published by Dryden Publications, Ltd., London, price 21/-.

The history of the development of the Port of London is a fascinating subject and Mr. Bowen has written it most attractively. Since the records of the beginnings of London are fragmentary, much of the story has perforce to be built up on inference. Thus, on some details, one man's opinion is as good as his neighbour's and criticism is out of place. Mention must, however, be made of one omission in this book. The building of the banks of the river were perhaps the most significant physical development of the Thames. It is still a matter of conjecture as to who was responsible for this work. It is clear that the embankments were the work of man and that without them London River would not have been a most important economic factor in the development of the Port of London. In spite of not mentioning this point, Mr. Bowen has brought the story of the "imperial port" up to the present period and has made a most important contribution to the literature of London.

The book has, however, much additional value for merchants and traders. Maps of each of the five large dock systems are included, with the numbers of the berths clearly shown. The dimensions of docks, lock and cuttings are given together with the names of the principal shipping companies using each group. Information also covers the tides, the bridges, details of export arrangements, road access and a very useful section devoted to the private wharves.

In short, this book is one which all merchants, shipowners and manufacturers who use the Port of London should have available for reference in their offices.

London Bridge and the Pool, by A. G. Thompson, 103 pp., with many illustrations. Published by Allman & Son, Ltd., price 3/6.

Often when we "stand and stare" at a well-known scene we feel the desirability of having a well-informed partner who, without disturbing our meditations, can quietly interpolate interesting remarks to explain the history, origin or meaning of the familiar details.

Most Londoners lounge on the parapet of London Bridge at some time or other and many know little of the significant scene spread before them. For these people, Mr. Thompson's little book is the very thing, for it fits unobtrusively into the pocket and the information it contains is conveniently divided into short sections, easy of reference and full of interest. For example, large Swedish ships often attract much attention as they lie alongside New Fresh Wharf—there are some paragraphs about them in this book. The Dutch ships at Hay's Wharf maintain such a regular service that something seems lacking when the berth is not occupied, they find a place in the book also. When the huge bulk of a collier glides through the bridge just beneath the feet of the passing crowds, there are many who would like to know something about these ships. This little book supplies the information, not exhaustively, of course, but sufficient for the passing moment and is an excellent aperitif for further research, especially in historical events of which the book contains many interesting stories.

"Ports of the World" edited by Sir Archibald Hurd and published by The Shipping World Limited, Effingham House, Arundel Street, London, W.C.2 (price 40/- post free).

The third edition of this publication has just been issued. It is an extensive and valuable work of some 1,200 pages, and gives detailed information of practically every port in the world of any importance. It has been possible for the first time since the war to include up-to-date particulars of the majority of the Japanese ports. Further information about the the incidence of public and local holidays has been incorporated in the text, and new features which have been added for the first time, include tables of steaming distances. Other features include a table of foreign currencies and a 16-page map section.

The arrangement of the present edition follows the same general lines as before. The first section embodies particulars relating to ports in the United Kingdom and Eire, arranged in alphabetical order, and the remainder of the book gives details of Commonwealth, Colonial and foreign ports, arranged according to continents and countries. A particularly useful feature is the comprehensive alphabetical index of overseas ports which enables instant reference to be made to any particular port.

"Die Mineralischen Baustoffe" (Mineral Building Materials), by Rudolf Zollinger. Price 8.50 marks.

"Binde—und Zusatzmittel fur Mortel und Beton" (Cement and Aggregates for mortar and concrete), price 3.50 marks.

These two small volumes published by Wilhelm Ernst & Sohn, Berlin, contain a lot of useful information for students and engineers upon the selection, mixing, testing, and efficient use of various rocks in building construction. They also deal with the characteristics of a number of minerals and cements used in the mixing of concrete, etc. Dr. Zollinger has in 150 pp. and 90 illustrations given a straightforward resume of many practical methods to ensure efficient service from the use of inferior building materials, the result of many years research and teaching in the laboratories of the Hochschule at Karlsruhe. R. R. M.

Chain of Rocks Canal

Improvement of Mississippi River

By Col. R. E. SMYSER, Jr.
(Corps of Engineers, District Engineer, St. Louis, Missouri).

In the interest of navigation the improvement of the Mississippi River above the mouth of the Ohio River has been under way since 1837, when Congress provided funds for the construction of St. Louis Harbour.

The present authorized project for the improvement of the Mississippi River above the mouth of the Ohio River provides for a dependable channel nine feet in depth from the mouth of the Ohio River to Minneapolis, Minnesota. From Cairo, Illinois, at the mouth of the Ohio River, to Alton, Illinois, at river mile 202.9, improvement has been by open-river regulating works. Between Alton and Minneapolis, river mile 857.5, the nine-foot channel is obtained by a series of 26 locks and dams. The most southerly of these dams, the Henry T. Rainey Dam (Lock and Dam No. 26) at Alton, extends the pool up the Illinois River for 80 miles, and together with 7 additional locks and dams on that river, makes a nine-foot channel available to the Great Lakes.

Navigational Hazards.

From the earliest days of navigation on the Mississippi River there has been a reach of the river just north of St. Louis Harbour that has interfered in varying degrees with river traffic. This section, known as the Chain of Rocks Reach, extends 7 miles along the Northern boundary of the City of St. Louis, being roughly that section of river between Merchants and Chain of Rocks Bridges.

At two locations in the Chain of Rocks Reach ledges of rock extend from the right or west bank under the river channel. These ledges act as natural weirs, or submerged dams, causing a sharp increase in slope with consequent excessive velocities. Under present conditions in this 7-mile reach at low water there is a total fall of about 11 feet or an average of approximately 1.5 feet per mile. This fall can be compared with the average fall of about 0.5 foot per mile in the upper Mississippi River above the Chain of Rocks Reach and an average fall below that section from St. Louis to Cairo of 0.6 foot per mile. The velocities produced in the Chain of Rocks Reach, sometimes exceeding 12 feet per second, make this section exceedingly difficult to navigate, and require double tripping of even the most powerful towboats.

Further, at extreme low water, navigable depth may be reduced to as little as 5.5 feet, thus preventing the full use of the improved waterway available above and below the Chain of Rocks Reach.

By Congressional resolution dated 31 October 1938 the Chief of Engineers was requested to prepare a report setting forth a plan of improvement of the Chain of Rocks Reach. This report was submitted on 15 December 1938, printed as House Document No. 231, and included in the River and Harbour Bill approved by Congress in 1939; however, this bill was vetoed by the President in view of the imminence of war. The project was again approved by Congress in the River and Harbour Act of 2 March, 1945, and signed by the President.

The Proposed Canal.

The approved plan contemplates a lateral canal on the left bank, or Illinois side, of the Mississippi River between river miles 184 and 194.5, with a large main and auxiliary lock at the downstream end of the canal approximately due west of Granite City, Illinois. In addition, a low-head movable dam with navigation pass is authorized just below Chain of Rocks Bridge, although construction is to be deferred until completion of the lateral canal, and further lowering of the low water plane at Lock and Dam No. 26 makes it desirable. The north end of the canal will be approximately one mile south of the mouth of the Missouri River, and the south end of the canal will be adjacent to the Granite City Engineer Depot and approximately 3800 feet upstream of Merchants Bridge. The canal will cross the slough behind Chouteau Island at several points and follow Cabaret Chute for 3 miles on the lower end. The total length will be approximately 44,300 feet, or 8.4 miles.

The bottom width of the canal will be 300 feet. The width at the top will be approximately 550 feet. The depth of the cut will vary from 10 to 45 feet, the average depth being 32 feet. Excavation will be approximately 28,000,000 cubic yards of earth, the material excavated being used in levees paralleling the canal.

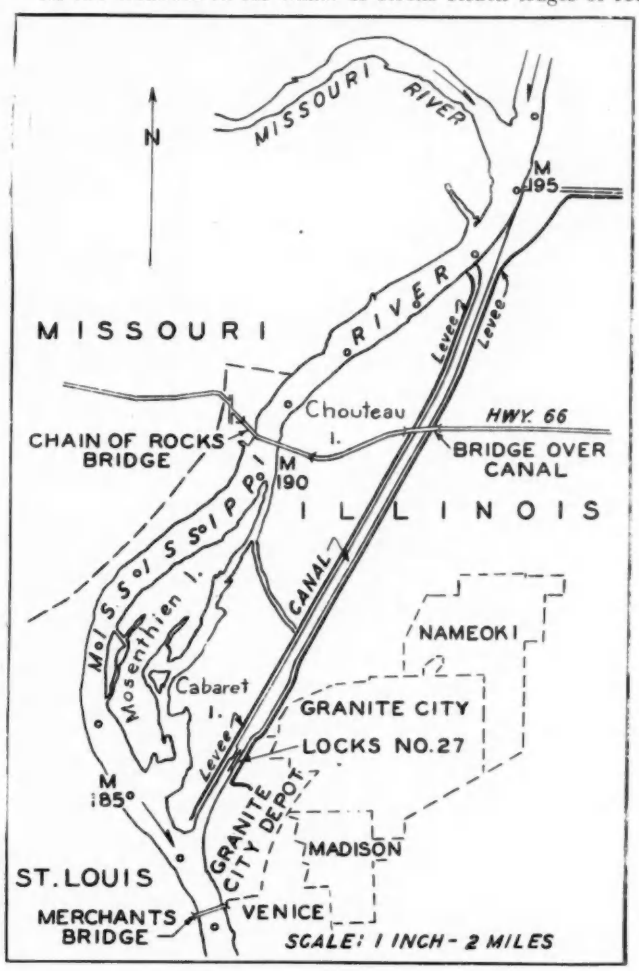
The elevation of extreme low water of record at the downstream entrance to the canal is 376.8 feet m.s.l. (above mean sea level); accordingly, the bottom of the canal downstream of the lock is at elevation 362 feet, thus providing a depth of slightly less than 15 feet at extreme low water. This will permit further lowering of low water plane without entailing a deficiency of depth in this part of the canal. The elevation at extreme low water of record at the upstream entrance of the canal is 388.4 feet m.s.l. The bottom of the canal at this point will be at elevation 378, leaving a minimum depth of 10.4 feet.

The Locks.

Near the lower end of the canal a 1200-foot main lock and a 600-foot auxiliary lock will be located. Each lock will be 110 feet wide. The main lock will be the longest lock in the Mississippi River system and will permit passage of the longer tows now in service without the necessity of breaking them. The upper lock gate sills will provide approximately a 14-foot depth at extreme low water of record and the lower gate sills will be 16.8 feet below low water of record. Lock walls will be approximately 92 feet high. The structure will be founded on bedrock. About 400,000 cubic yards of concrete will be required for the two locks.

The upstream gates are unusual. During the winter it may be necessary to pass ice through the lock chambers and since it is impracticable to operate mitre gates against an appreciable head of water, double-leaf vertical-lift type gates are used. In addition, these gates will pass flow to aid in filling the lock chamber. Each leaf will be 30 feet high and each gate consisting of two leaves will weigh about 900,000 pounds, or 450 tons.

The downstream gates will be of the mitre type and in the main lock each leaf will be 61 feet long, 72 feet high, and will



Chain of Rocks Canal—continued

weigh about 200 tons. In the auxiliary lock each leaf will be 43 feet high and will weigh 140 tons. Gates will be operated electrically.

The normal lift of the locks will vary from 5 to 11 feet, depending upon river stage. After the dam is built, the maximum lift of the locks at low water will be 21 feet. About 2,940,000 cubic feet of water will be handled through the main lock for each lockage of 21-foot lift, and at this maximum lift the time required for filling the main lock is 7½ minutes.

Levees will be constructed on each side of the canal to an elevation of 439.5 feet m.s.l. to protect against a flood equal to the highest of record (1844) with 2 feet of freeboard (approx. 1,300,000 cubic feet per second). The width at the crown will be 20 feet. The toe of the levees on the canal sides will be about 150 feet from the edge of the cut to prevent displacement due to the weight of the levees. Berms extending out from the levee within 25 feet of the edge of the canal will be built to elevation 421. The levee on the east side of the canal will become a component part of the East Side river front levee system which protects the valuable industrial area adjacent to East St. Louis, Illinois. Approximately 28,000,000 cubic yards of material will be excavated for the canal and placed in the levees.

Supplemental Dam.

If necessary after the canal locks are complete, to insure adequate river depth at low water over the lower mitre sill of Lock No. 26 at Alton, a supplemental low wicket-type dam will be constructed in the Mississippi River at mile 190.4 about 500 feet downstream from Chain of Rocks Bridge. This dam will consist of a low concrete spillway with fixed crest at elevation 395.7, extending from the Missouri bank riverward about 800 feet, 552 feet of additional spillway with sill elevation of 387 and 1,328 feet with sill elevation of 379.6, both provided with chanoine wickets. A navigable passage 780 feet wide will be provided in direct line with the navigation span of the Chain of Rocks Bridge. Sluiceways or conduits without gates are proposed under the longer wicket sill to pass silt from the pool to the channel below the dam. Elevation of the pool is planned at 398 feet, m.s.l.

Harbour Facilities.

Immediately above the locks the canal will be widened for a distance of 6,750 feet to a bottom width of 700 feet in order to procure material required for levees and to provide harbour facilities for industries in the Tri-Cities and others.

Highway Bridge.

A bridge located east of the Chain of Rocks Bridge, approximately 3 miles west of Mitchell, Illinois, is now being constructed to carry re-located U.S. Highway No. 66 over the canal. The bridge will consist of 17 spans and have an over-all length of 2,368 feet and a roadway width of 22 feet. The span over the canal will be 465 feet long and will have a clearance of 50 feet over the maximum stage at which the locks will be operated, with a clearance of 42.5 feet over high water. The height of the canal span piers is 99 feet, 4 inches, and the depth of the footings for these piers is 7 feet.

Before construction of the canal can proceed, it will be necessary to relocate certain utilities which now cross the right of way, so as to pass underneath the canal. The utilities to be moved are: One 10 inch gas pipe line, owned by the Mississippi River Fuel Corporation; one 18 inch and one 20 inch cast-iron water line owned by the East St. Louis and Interurban Water Company; one 54 inch lock-joint concrete water line owned by the East St. Louis and Interurban Water Company; and one 10 inch and one 16 inch steel oil line owned by Shell Pipe Line Corporation.

Land Acquisition.

Certain land and right of way are necessary. The land needed is in 78 separate parcels, comprising approximately 2,500 acres. Included in this area are 7 sets of farm improvements and 35 cabins and small residences. In addition, there are 14 other miscellaneous buildings. In acquiring this property the Government has not set an arbitrary price on the buildings or land. Each tract is appraised separately and the Government seeks to pay the owner the fair cash market value of each tract of land together with any improvements that may be on the land. " Fair cash market value " does not mean the amount the owner may have paid, but represents what the property could be sold for on the open market by one who was willing to sell but not obliged to sell to one who was willing to purchase but not obliged to purchase.

Upon completion of the Chain of Rocks project the last serious impediment to full utilisation of the 9 foot channel extending from New Orleans to Minneapolis and the Great Lakes will be removed.

Progress of Construction Works.

Work has been in progress on the locks since June 1947, and by February 1949 approximately 53,300 cubic yards of concrete had been placed out of a total of approximately 400,000 which will be required.

Of particular interest, perhaps, is the modern concrete plant. Rough aggregate of three sizes and fine aggregate of two sizes are delivered to the job direct from the quarry and placed in storage bins by bottom dump railroad cars. From the storage bins the aggregate is carried over a system of belt conveyors to the mixing tower (the photographs will show the mixing tower and the trestle on which the belt conveyors operate). Cement is delivered to the job in bottom dump cars and stored in a cement silo. The cement may be delivered to the batching plant either direct from the cars or from storage. This delivery is accomplished by air activators which because of the proper air mixture with the cement permits delivery by pipe to the batching plant. The temperature of the cement mix is controlled through the control of water temperature. In warm weather this involves the use of approximately 100 tons of refrigeration capacity which cools about 84 gallons of water per minute through a 25° temperature range. In winter steam is used to temper the water. The ingredients, including coarse aggregate, fine aggregate and cement are stored in hoppers at the batching plant. The batching of the ingredients is controlled by one man through a electropneumatic control system which accurately measures and weighs the ingredients into the mixers.

There are three 3 cubic yard mixers which deliver the wet batch to a lower level into a wet batch hopper from which it is placed in specially designed three cubic yard buckets on railroad cars and delivered to the forms. The entire conveyor, batching and mixing operation is handled by six experienced workmen.

View looking south from the centre plug of the cofferdam, showing lock under construction.

Chain of Rocks Canal—continued

The photographs show special tarpaulin protection to the monoliths for winter operation. In order to control the curing of the cement in the form, steam heating is supplied from two locomotive boilers.

The highway bridge on relocated U.S. Highway 66 has been completed and will be placed in service when the highway has been constructed.

The contract for the construction of the canal has not been let, but it is anticipated that quotations will be received within the next few months. The locks are expected to be ready by the end of 1950, by which time the canal should also be completed.

Artist's impression of the locks as they will appear when completed

New Radar at Wallasey Ferry

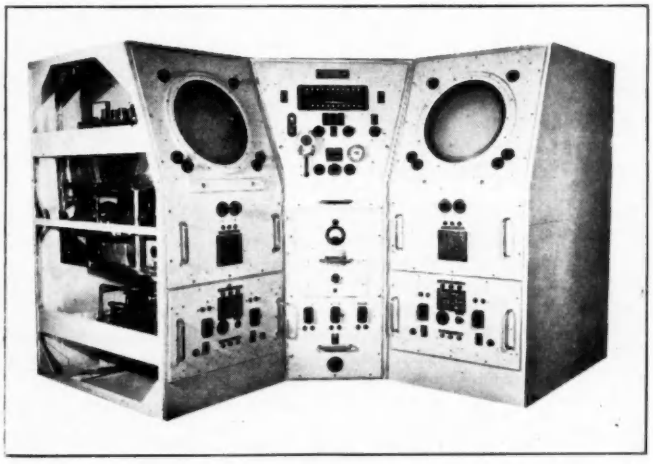
Improved Set Now Installed

(BY A SPECIAL CORRESPONDENT)

On the 28th July the Transport Minister, Mr. Barnes, presided over the installation of a new Cossor Marine Radar shore-based equipment to replace the existing C.M.R. control operating with the Wallasey Ferry Corporation. This ceremony marked a step forward in the sphere of harbour and ferry control where—in a few short years—radar assisted shipping in restricted waters has reduced by over 80% the long delays attendant on bad visibility or fog.

As stated in a previous article in *The Dock and Harbour Authority*,* Cossor Marine Radar was first installed with the Wallasey Ferries just two years ago and to quote the written word of Commander L. D. Price, General Manager of the Corporation, " it has been working . . . with results far surpassing those anticipated." Although the ferry service transports twenty million passengers annually, it was often delayed by periods of dense fog. With radar this service has maintained its cross-river schedule of eight minutes under the most adverse weather conditions when—otherwise—it might have come to a standstill.

*October, 1947.



View of the new Console with side panel removed.

Following the preliminary technical discussions and experiments, it was finally decided to make the Wallasey Ferry a shore-based control. This decision rested upon the important fact that the master and mate of a ferry-boat—navigating in busy waters with a possible five to six knot tide running—could not spare time for constant study of a radar screen upon the bridge. The shore-base ultimately chosen was behind Seacombe Landing Stage and a two-way communication with the ferry boat established by radio-telephone. The master is informed of other vessels in the proximity, their distance, bearing, the direction they are travelling. It is left to his discretion how he uses this information, received through a loud speaker on the bridge.

Since the initial installation of C.M.R. equipment, however, Cossor experts have set themselves the task of improving the overall efficiency of the standard set, bearing in mind the difficulties of a shore-based station plotting a ferry service across one of the busiest waterways of the world. The new console equipment mentioned in the opening paragraph to this article is the fulfillment of this research in which Cossor engineers have incorporated the most up-to-date technical knowledge.

As can be seen in the accompanying photograph, the console consists of two P.P.I. units arranged slightly at an angle, either side of a central control panel. A side panel has been removed to give interior view of the Indicator assembly and power unit. These and all other parts of the overall assembly can be pulled out on runners, providing complete accessibility for servicing requirements. The Cathode Ray tubes are 15-in. in diameter (compared with the present 9-in. single tube) so that a much larger " picture " of the river can be obtained. The radar operator can observe either screen with a slight movement of the head. Time base ranges of between 0.6 and 7.5 miles are available; in this particular installation they are set to give 0.8 and 1.6 miles on one P.P.I. and 4.8 miles on the other. By this means, the operator has two sources of information to hand. He can observe in detail the actual ferry route—using the close range display—and receive advance warning of approaching shipping from the long range screen. Thus the information he can pass by radio-telephone to the master of the ferry-boat is obviously of a much more detailed character.

Another feature of great value in a shore-base station, plotting in one direction only, is that the electrical centre around which the time base rotates—this centre represents the radar station—can be offset by approximately a third of the tube diameter. This permits a far greater area of the tube to be used for display . . . on the 0.8 mile range, for instance, the River Mersey is shown as approximately 7-in. wide as compared with 2-3-in. with the present installation.

New Radar at Wallasey Ferry—continued

It should be stressed that simply increasing the size of display on a larger C.R.T. is in itself no great advantage; the object of C.M.R. engineers has been to give a more accurate P.P.I., not merely a more amplified one. This has been achieved. The IF band width is 20 megacycles, the video amplifier 10 megacycles wide, thus pulse shape distortion is kept to a minimum . . . this increases the discrimination so that two objects of very close proximity can be seen as separate responses where formerly it was impossible to differentiate between them.

Further improvement is effected by stabilised focus so that once set it maintains a clear focus over the normal range of supply mains fluctuations. A 10 kv Extra High Tension supply to the cathode ray tube speeds the electron stream and helps to produce clearer, more precise responses.

Swept Gain, a device which increases the sensitivity of the set as the range increases, is fitted so that the magnitude of clutter, caused by very close range responses, is reduced without affecting those at longer ranges; this enables shipping to be guided in much nearer to the landing stage.

Of particular interest is the Variable Range Marker. This is a circle of light, similar to the calibration rings, which can be placed over any particular response on the P.P.I., automatically giving the range in yards on counter dials. Precise distances can therefore be given to the ferry boat master during the crossing where previously—at times—he had to rely upon close estimations.

The console retains the ease of manipulation familiar to all C.M.R. equipment. In design, the operator has not been forgotten; sitting before this new shore-based radar control of the Wallasey Corporation Ferries he is made to feel, as indeed he is, in full command of any situation which might arise.

The Payment of Dock Workers

Operation of System under the National Dock Labour Board*

By A. BAILES, Stud.Inst.T.

"The principal characteristic which has distinguished dock work from the majority of other industries is the casual nature of the employment offered to those engaged in the loading and unloading of vessels. The availability of employment and the amount of it in relation to the number of men seeking work in a port are dependent upon a variety of factors which, in the main, are outside the control of those responsible for carrying on the industry and which result from the uncertain and irregular arrival of the vessels."

In that extract from the Foster Report, is the crux of the problem which has confronted the Port Transport Industry since the beginning of the century. To it I would add that the principal "factors" are:—

(a) the fluctuations from year to year, or even month by month, in the **total** volume of trade;
(b) the ups and downs of trade in a port area, which may be local in character as distinct from the national movement;
(c) the effect of seasonal trades, e.g., timber imports;
(d) the irregularity which results in gluts of shipping for several days, even though the total volume of trade may be low.

The Events Leading up to the Present System

All the efforts of the industry and all the schemes introduced during the past thirty years have been concerned with this problem:—the marrying-up of the labour supply with the demand resulting from sea-going trade. At the outset it was recognised that the prime factor in any scheme was the compilation of an effective register of port labourers and in 1912 the first steps in this direction were taken in Liverpool. It is not my intention, to give a list of the efforts made which resulted finally in a permanent scheme for the Decasualisation of Dock Labour. It can be said however, that in 1939 there were no compulsory and but few voluntary schemes of Registration in operation which could be described as effective, although, as previously stated, as far back as 1912 a registration scheme for the control of entry into the industry had met with a certain measure of success at Liverpool, and was followed by others, notably at Bristol. By September, 1939, registration schemes had been set up in all the ports excepting Aberdeen and Glasgow, but the schemes were not all of the same form and often the registers of labour were "out of line" with the requirements of the ports.

The object of this paper is to give a picture of the pay systems in force at the beginning of the century, and, as later experienced and seen by me, in Middlesbrough, but nevertheless reproduced to a major extent in every port throughout the country; then to enable you to make a comparison, to show how the present system operates under the National Dock Labour Board.

The System Prior to 1919

Before the first World War the labour attracted to the industry was, generally speaking, of a low order. It consisted of a "core" of good workers, but the residue were the discards of other industries, men who, failing to keep their employment in other trades, knew they could turn to the docks industry without being questioned as to their character or ability. These men, probably as the result of information received from their workmates, would present themselves at certain "call" times at a dock or wharf at which a vessel had arrived for loading or discharge. Where the man went, therefore, depended chiefly upon himself, though the system of registration, when applied, resulted in his reporting at the place at which he was registered, or, if no work was available there, at a neighbouring wharf.

The hours of work at Dent's Wharf, Middlesbrough, were as follows:—Day shift—6 a.m. to 5 p.m., and Night shift— 5.30 p.m. to 5.30 a.m., and just before the commencement of the shifts the men gathered in the "market" to be chosen for work. In addition to these starting times they also gathered during any of the recognised break times, i.e., 8 to 8.30 a.m. breakfast;12 noon to 1 p.m. dinner; 9 to 10 p.m. supper; and, in fact, were picked whenever needed at any time during the normal hours of work. Their engagement terminated at the discretion of the management, that is to say, at whatever time they completed their job or, if so desired, at the end of any quarter shift. The main point to note was that the men might present themselves at any of these call times and yet not be engaged. The method of choosing the men for work is probably known to you—the congregating of the men in the market and the mounting of the foreman to a vantage point from where he could view the men and pick those required. It is obvious that the whole system was unsatisfactory both from a social and an industrial point of view.

The system for the payment of the men's wages was also unsatisfactory. The men were hired by a contractor, or Master Stevedore, who was paid by the shipowner on a tonnage basis for doing the job. He, in turn, paid his men either piece or time rates, usually passing the money on to his foremen to distribute amongst the gangs. It was not unknown for the money to be handed over to the men in the local public houses and you can imagine what opportunities for social evil arose from such a method.

The 1919 to 1940 Period

After 1919, and until they were altered as a wartime measure in 1940, the times of work were as follows:—day shift, 6 a.m. to 2 p.m.; night or afternoon shift. 3 p.m. to 12 mid-night; the call times being a few minutes before 6 a.m., 10 a.m., 3 p.m. and 8 p.m. In December, 1932. it was decided that when men were required to start a boat at 8 p.m., to work the customary four hours, they must be ordered at the 3 p.m. call.

By 1936 the pay system had also altered somewhat and the following procedure was carried out at Dent's Wharf, Middlesborough. At 11 a.m. we started to pay those men who had worked the previous afternoon shift, and in order to do this it

*Abridged Paper read before the Middlesbrough Graduate and Student Society of the Institute of Transport on Nov. 5th, 1948, and reproduced by permission.

The Payment of Dock Workers—continued

was first of all necessary to enter in the Wages Book the names of the men, the ship and the hold in which they had worked, the cargo shipped or discharged, and the time taken. All this information was received from a copy of the Wharf Foreman's Report, which was brought to the wages office at the end of the afternoon shift. From this information, assessments were made of each man's earnings according to the tonnage handled; the class of commodity and any peculiar conditions appertaining (e.g., " long carry," " dirty money," " waiting time," etc.) were also taken into consideration. The rates of pay were scheduled in a River Rate Book, as agreed between the Employers and the Men's Union. Nevertheless, this tariff was not all-embracing and many classes of cargo were not covered, and certain conditions called for special agreement of rates on the part of the management and the men.

The approach of 11 a.m. was evidenced by the gathering of the previous night's workers outside the wages office, and by the time we commenced payment there was something approaching an orderly queue. Each man was paid in cash the amount of his previous night's earnings and a pencilled record was made of each payment as it was passed out of the pay window. The fact that the man concerned had received his due amount was noted in the Wages Book by a pencilled tick made against the amount shown to his credit. At the completion of the pay, the balance of cash remaining in the cashier's possession was totalled and checked against the pencilled record of payments, and the agreed balance was noted in the latter record for the commencement of the next pay. It will be seen that the possibility of error in payment far exceeded that existing in any normal pay system, no check being given to the cashier's counting of the money from his cash box for handing to the men and generally a failure to balance at the end of the pay was, in the absence of a discoverable error, a loss either to the cashier or his employer. Sometimes the failure resulted in a gain, but in this case the money was placed and held in a " Kitty " to meet contingencies similar to the above.

The payment of the 6 a.m. to 2 p.m., shift workers should have been made at the completion of the shift, but you will appreciate that to have done this during busy periods would have meant the men not leaving the wharf until long after the finish of the shift. Therefore, at the men's request, we compromised and at 1 p.m. each gang working sent its appointed representative to the wages office to receive on their behalf an amount on account of their anticipated earnings. The representative was also given a slip of paper on which was clearly shown the earnings of each member of his gang, the originals of these slips being kept in book form by the cashier as evidence of the amounts paid and the person to whom they were given. This 1 p.m. payment had the dual effect of avoiding the necessity for all the men to come to the wages office at the end of the shift and it reduced to some extent the time occupied in the actual payment of the wages. This " Sub," as it was more generally known, was assessed on the men's probable earnings, but with some safety margin to avoid the necessity of recovery of over-payments—no easy matter when, as often happened, some of the men reappeared only after several weeks, or maybe months, had elapsed. The procedure as described for the 11 a.m. pay was repeated for this payment, i.e., booking of payments and final balancing of cash.

After the end of the shift at 2 p.m. the earnings were calculated exactly and the balances outstanding were paid the following morning at 11 a.m., or, if the men were working again that day, with the 1 p.m. " sub."

At 5 p.m. we paid those time workers who operated on an 8 a.m. to 5 p.m. basis, viz., Warehousemen, Yard Labourers, etc. It will be noted that even these workers were employed on a casual basis, i.e., from day to day.

Having dealt with the actual payment of the wages we were then left with the accountancy. From the Wages Book we posted the men's earnings to a Wages Abstract Book, which, when each man's account had been totalled, gave us his weekly earnings. These weekly amounts were then posted to the Wages Weekly Book and in this was also kept a record of the man's stoppages, viz., Hospitals Fund, Unemployment and Health Insurance contributions, etc. Then from the Wages Weekly to the Wages Cash Book, where the balance was struck between the wages paid and the cheques received, and the half-yearly and yearly figures for wages were ascertained.

Some Disadvantages of the Pay System and the Anomalies Arising under the Unemployment Insurance Acts

To the Undertaking:

1 (a) For far too great a proportion of the working day the wages office staff were at the disposal of workers who cared to call at the office in respect of actual pay and balances due, and queries relating to earnings. Consequently, the relative time available for the recording of transactions, making of investigations and entering of accounts was limited and, moreover, hardly free from interruption.

(b) There was a greater chance of error in the assessment and the payment of wages owing to the speed at which they had to be made.

(c) The factors affecting the amount of work offering, the different classes of cargo handled and the varying quality of the workers engaged made for fluctuations in tonnages shipped and discharged, so that it was never known what sums of money would be required to pay the daily wages of the workers. In these circumstances it was necessary to keep large sums of money on the premises.

2 No matter where the dock worker obtained his first shift's work in any week, the firm so employing him was responsible for the stamping of his Unemployment and Health Insurance cards. It was possible then that an industrial employer might be contributing more than his fair share to the Unemployment Insurance Fund.

To the Worker:

The worker, or more especially, his wife, must have found budgetting on such an unstable day to day basis a very trying business, the wife hardly ever knowing what her man earned!

The Abuse of the Unemployment Benefit:

At this time there was left open to the unscrupulous worker the opportunity of abusing the Unemployment Assistance benefit. In order to obtain benefit and, in this connection, the Ministry of Labour week ran from the Thursday to the Wednesday, a man had to have a minimum of three signing days in any series of six days. This would entitle him to three days' benefit, but if in the series of six days he had four, five or six signing days, then, of course, he got paid for that number.

A man by working one day could, therefore, forfeit two days " Dole," which put him in the position of, as it was familiarly known, " working for fivepence." Take for example a man who for a full week's unemployment received 24s., i.e., 4s. per day. If he signed on Thursday and Friday for which the benefit would have been 8s., and then worked for the remaining four days of the week at a rate of say 11s. per day, he would forfeit the 8s. benefit and only receive his 44s. actual earnings. But, if he signed three days, for which the benefit would have been 12s. and worked the remaining three days at 11s. per day, he would receive a total of 45s. for that week, i.e., 12s. unemployment benefit and 33s. actual earnings. He would, therefore, gain a shilling by not working the third day.

It was well known that the men could and did calculate their entitlement to benefit and avoided, by various means, the loss of any day's entitlement for which they had signed at the Employment Exchange. For the year 1929, figures taken from a Statement of Benefit and Contributions in respect of workers in the Docks and Harbour Services in Great Britain show just how great was the sum involved:—

	£
Employers and Employees Contributions	372,100
Contributions by the State	175,300
Total Contributions	£547,400

Total Benefit Paid during Year: £2,913,000.

In this one year, therefore, the loss to the unemployment Fund was £2,365,600.

The Payment of Dock Workers—continued

By comparison the present figures under the National Dock Labour Board for the half-year ending 3rd June, 1948, are:—

	£
Attendance Money paid in the Reserve Pool	513,370
Guaranteed Make-up	48,763
Total	£562,133

If this figure is doubled to give an estimated yearly total we have £1,124,266 and, as I will explain more fully later on, this total must be borne in full by National Dock Labour Board.

The Outline of the Present-day System

Having shown something of the old system as it was, let me turn to the present system under the National Dock Labour Board. The following are the fundamental features which distinguish the payment of Dock Workers under a Guarantee scheme from any other pay system normally employed.

(a) The docker is often employed by several firms during the course of his working week, not, as in normal industries, by the same employer. Some consolidated and central wages payment is therefore necessary.

(b) In the old days the employer having obtained all the men he needed to man his ships could, without redress, turn away those he did not require. Nowadays the employer must give, **in advance,** his labour requirements from day to day and shift by shift. In face of the vicissitudes of trade he can be left with an excess of labour on his hands. Who is to be responsible for the payment of these men?

(c) With the introduction to the industry of " Holidays with Pay," a thing unknown to the old-time casual docker, who is to be responsible for the payment?

(d) Other questions such as the payment of the Employers' Unemployment and Health Insurance contributions, the Employers' and Employees' obligations and Disciplinary Procedure require comparatively little answering in other industries, but in the docks industry all had to be settled before any scheme for decasualisation could operate.

They were indeed all settled with the coming into being of the National Dock Labour Corporation in 1941, and further qualified under the rules and regulations of the National Dock Labour Board, which was brought into operation on the 1st of July, 1947, by an Act of Parliament providing for a permanent scheme of decasualisation, known as the Dock Workers' (Regulation of Employment) Act, 1946. The registered dock worker now has a security of employment which compares most favourably with that of workers in other industries, and, as must have been hoped, the security is gradually bringing a change for the better in his outlook and approach to his work.

The National Dock Labour Board and the Local Boards

The members of the National Board are appointed by the Minister of Labour and National Service after consultation with the National Joint Council for the Port Transport Industry, and consist of a chairman, vice-chairman and eight other members representative equally of the workers and employers. The main functions of the National Dock Labour Board are to facilitate the economic turn-round of ships and to control the supply of dock labour in the ports by **the fixing of the size of the respective registers.** In order that these functions may be carried out efficiently the National Board appoints Local Boards in each port and delegates to them the authority to implement the functions at a local level. The Local Boards also consist of equal numbers of persons representing the two interests and they keep the local registers and control the supply of dock labour to the registered employers. The National Board has the responsibility for the setting up of central pay offices in each port and, as agents for the registered employers, the payment of the earnings due to the daily workers from the registered employers. In addition, the National Board must pay the daily workers any monies due to them under the provisions of the scheme, i.e., " attendance and make-up money," and " travel-time allowances," etc.

Employers' contributions for National Insurance in respect of daily workers are the responsibility of the National Dock Labour Board; those of the weekly workers remaining, the responsibility of the appropriate registered employer.

Before going any further it will be as well to say what is meant by the terms " daily " and " weekly " worker:—

> " the daily worker is a registered dock worker who is not a weekly worker and the weekly worker is a registered dock worker who is engaged by a registered employer under a contract which requires at least one week's notice for its termination."

At some wharves the weekly workers were formed, at the inception of the scheme, from a nucleus of men who already had regular jobs, or who regularly sought employment at the wharves and who were therefore accustomed to the machines used and the methods of working. In the main, they comprised crane drivers, warehouse workers and certain yard labourers; in the case of crane drivers, they were doing responsible work involving the care of valuable machinery, and it was in the interest of the employer, as well as the men's, to have these workers for his exclusive use.

To understand how the functions of the Board are interpreted and brought into actual operation, let us trace the history of a recruit into the industry who, having satisfied the local registration committee as to his ability and willingness to work under the scheme, sets about earning his living, in this port of Middlesbrough.

There are three main categories of dock workers, " A," " B " and " C " and in Middlesbrough and The Hartlepools these are defined as:—

Group " A " Men able to fulfil all the conditions of the scheme, including period transfer.

Groups " B " and C " Men by reason of age or physical incapacity unable to perform a full week's work and/or not suitable for transfer.

These categories are applied, as the case may be, to registered dock workers already within the scheme, but our recruit to be accepted in the first place must be Group " A."

He will be given a registration book by the Local Registration Committee and will have either been allocated to a registered employer or entered on the list of Supplementary workers. If he has been allocated to a registered employer, that employer has the first call upon his services; if in the Reserve Pool he must work wherever he is sent. In general he will work alternate weeks of day and night shifts, but certain wharves work their allocated men for two weeks on days and one week on nights.

Under the Act all Class " A " workers are entitled to a Guaranteed Weekly Wage of £4 8s. 0d. As a set-off against the guarantee, " attendance money " is paid at the rate of 5s. per turn, and if in the course of a week the man's earnings plus the attendance money for those times he does not work do not total £4 8s. 0d., then the total is made up to that figure by the payment of what is termed " guarantee," or more popularly, " make-up " money. It must be noted that any earnings in respect of work performed between normal finishing time on Saturday and Sunday mid-night (or the start of the Sunday night shift), are exclusive of the guaranteed weekly wage, and are known as " Non-Guarantee earnings."

The " A " man must attend the call point for eleven turns (Monday to Saturday), the " B " man nine turns, and the " C " man six turns. In Middlesbrough the eleven turns per week operates as twelve turns on day shifts and ten turns on nights. The weekly guarantee of the " B" man is reduced to nine-elevenths of £4 8s. 0d., which equals £3 12s. 0d., and that of the " C " man to six-elevenths, which equals £2 8s. 0d. There are also special clauses for men in the 65-69 age group who are paid attendance money for the number of their turns, but who have a reduced guarantee, e.g., eleven turns 66s., six turns 36s. Men of 70 years and over have attendance money for six turns but no guarantee wage.

When a man is ordered by the Registered Employer and for whatever reason it happens that he cannot be put to work, then the Employer is responsible for the payment of a minimum of one-half shift at the appropriate rate to the man. The second half shift of that day is covered by an attendance stamp if the man is not sent elsewhere for work.

The Payment of Dock Workers—continued

If after working at a wharf the man is needed by that same wharf for the following day's work, his registration book will be retained at the wharf and this retention guarantees him a minimum of one-half shift's work, or payment in lieu, on the next day. If at the end of his engagement the man is no longer required, his book is stamped and returned to him and he will then attend his next call at the control point.

The Present-day Wages System

The man, having been allocated for work at a wharf, has his name and registration book number taken by the foreman and entered on the firm's " Report of Work Done" Sheet. At the end of the shift the tonnages for the cargo he has handled will be recorded and the copy of this report is then sent to the wharf wages office. Here, the assessment of his earnings for the shift are made; this being done on loose leaf sheets, the originals of which are retained in the office and the copies posted up on the Notice Board outside the wages office. The man can then see the amount of his earnings, and, if he chooses, can keep a record of all his daily earnings at the different wharves during the week, so that when he draws his pay from the National Dock Labour Board he has a check on his gross amount. To enter into a discussion about the rates by which the men are paid would take up far too much of your time—sufficient to say that they are many in number and vary in accordance with the types and classes of commodities handled at the river wharves and the docks. A comprehensive knowledge of the rates therefore necessitates the wages cashier shall I say " growing up " with them, and is without a doubt a task for the specialist.

To describe in detail the pay system would take too long, but I would say that, in my opinion, the requirements of a good pay system are satisfied by that of the N.D.L.B. Firstly, the responsibility is spread over many agencies and individuals, viz., the allotment of labourers to different employers by the Port Labour Officer; the actual placing in employment of the men by the Wharf foremen or Master Stevedore; the assessment of the daily wages by the registered employer's wages cashier and the aggregation of the weekly wages by the chief clerk of the Local Board; then the actual making up of the wages packets by the clerks of the Local Board. Persons handling cash have no access to the accountancy side of the transactions and it would seem that collusion would be very difficult. All the time sheets and pay sheets are authorised by the appropriate officials and safeguards are taken to prevent fictitious entries of men or working times. The actual pay-out is properly conducted and the wage is paid only to the proper recipient. All unclaimed wages are returned to the Bank after a 14 days' interval. Finally, the routine balancing carried out by the individual employer and the N.D.L.B. office would quickly bring to light any attempt at fraud or mis-appropriation.

The National Dock Labour Board pay the Employers' contribution for National Insurance, and the drain on the country's Unemployment Fund such as existed before decasualisation came into operation has been almost completely removed now that dock workers are the responsibility of the National Board. Their unemployment whilst in the scheme is covered by the payment of attendance money, but if they become redundant and are dismissed the scheme then, of course, they become the State's responsibility. Incidentally, the National Board do not receive any subsidy from the Ministry of Labour in order to meet the payment of attendance money; they must make provision for their employees' lost working days from their own funds.

The wages paid to the dock workers and the conditions under which they work are in accordance with the National and Local Agreements—any problems arising from them are matters for men's union and the employers and do not come within the scope of the scheme.

Holidays

One week's annual holiday with pay is granted to each registered dock worker if he has given satisfactory service throughout the year, and is paid at the National Standard Time Rate for 44 hours, i.e., £5 4s. 6d. The Local Board has the final word as to the dates of the individual's holiday, but as far as is practicable they try to allocate to the men their chosen dates. The responsibility for the payment of the Weekly Workers' annual holiday is also the National Board's, but in this case the employer allots the workers' holiday dates, pays the men and then reclaims the amounts, up to £5 4s. 6d. for each man, from the Local Board.

In addition, the registered dock worker is entitled to six Statutory or Proclaimed holidays; that is to say, up to six days of any of the Bank Holidays or days recognised by the National Joint Council as being holidays within the port. Again, the payment for these holidays in respect of the daily workers is the responsibility of the National Board. The payments to weekly workers must be made by the individual employers and no liability attaches to the National Board for the amounts paid.

Obligations under the Scheme

The registered dock worker must report at the call stand or control point at specified times as required, and must accept any work in connection with port transport for which he is considered by the Local Board to be suitable. He must also, when required, travel to any other port or place within **daily travelling distance** of his home. Period transfer to ports outside the above range is purely voluntary. The registered employer must not employ a daily worker other than one who has been allocated to him. He must obtain the worker's registration book and stamp it in respect of each period of work and return it to him at the end of an engagement. The employer must return to the Local Board the statement of gross wages due from him to each dock worker in his employ, and pay the Local Board the total amount of the gross wages due to daily workers.

Disentitlement to Payment and Disciplinary Measures

Disentitlement to payment falls into two categories: (a) that which is automatic and (b) that which results from a decision of the Local Board.

Automatic disentitlement to attendance money and guarantee make-up would apply to any worker who fails to report at the call stand or control point at such times as he is expected to do so; the disentitlement applying to the whole of any pay week in which the failure occurred or continued.

If a worker is guilty of such offences as:

> refusing an offer of suitable employment, refusing to accept daily transfer, failing to comply with a proper order of the Local Board or the employer, or , failing to carry out his duties at work,

he does not suffer any disentitlement to payment of attendance money or guarantee make-up unless and in fact until the Local Board so determines.

Disciplinary measures are considered to be supplementary to disentitlement and where a worker is guilty of any breach of the scheme the following action can be taken by the Local Board:

(a) it can determine that the worker shall not be entitled to any payment for such period as it thinks fit,
(b) suspend the worker without pay for a period not exceeding seven days,
(c) give the worker seven days' notice in writing, or dismiss him summarily.

The worker is given the right of appeal against any of the decisions made against him by lodging a notice of appeal with the Appeals Tribunal within three days of his being informed of any decision. You may recall the circumstances of a recent London Dock Strike where a dock worker refused to handle a chemical cargo at the tariff rate—he was suspended for seven days and lost entitlement to his guarantee pay for thirteen weeks. On the appeal of the man, this figure was later reduced by Sir Robert Aske to two weeks.

Port Welfare

The National Board are alive to the benefits to both employer and employee that can accrue from a good system of port welfare and port welfare officers are now a feature of the scheme. The whole scope of this benefit is kept under review and progress has been made in many places. Social activities and sports organisations are functioning—in Middlesbrough the dockers contribute to a

The Payment of Dock Workers—continued

Sports Fund. Many dockers also contribute to their own Sick Fund from which assistance is given to workers in times of illness and replaces the old method of " collections " or " gatherings." At many of the wharves and docks there are canteens in operation, but these have been provided for the workmen by the individual employers and not by the National Dock Labour Board.

The Cost of Operating the Scheme

The whole cost of the operation of the scheme is borne by the payments made by the registered employers to the National Board. These payments take the form of a levy upon the Gross Wages of the Daily Workers (at the moment, 15%), together with the actual payment of these wages. In addition, the employer must also pay a levy upon the Gross Wages of the Registered Weekly Workers, (now standing at 5%).

The employer may claim a refund on this latter amount if his registered weekly workers have more than eighteen engagements in the quarter on Non-Transport work. He does this by making a return to the Local Board showing the total of the percentages paid in respect of such work, and after deducting fourpence per man-day for the privilege of using registered weekly workers on Non-Transport work, reclaims the balance.

Port Transport work in relation to any port has the meaning assigned to it in the Dock Labour Scheme for that port, and covers such operations as the loading, unloading, movement or storage of cargoes.

Marine Radar

Description of New Decca Equipment

(BY A SPECIAL CORRESPONDENT)

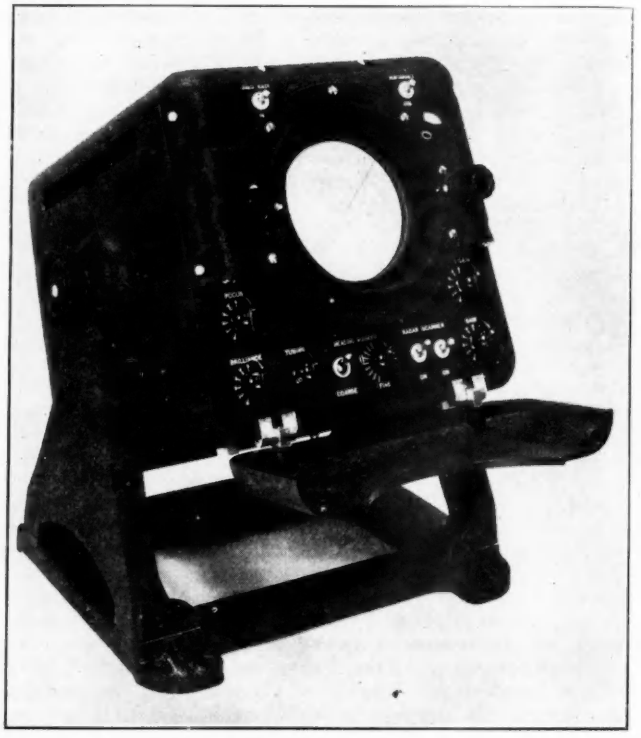
On the conclusion of the recent war, The Decca Navigator Company set out to develop and design a marine radar which, while meeting the most exacting requirements, would be capable of production at a greatly reduced price. It was also realised that in order to introduce radar to the smaller classes of merchant ships and coasters, it was essential that the design should be simplified, installation and maintenance costs reduced, and the overall size of the units decreased. An intensive research, development and design programme has therefore been conducted during the past three years with the result that an all-purpose radar has been produced which will serve all classes of shipping. Production has now commenced and a considerable quantity of the new radar sets will be available by the autumn of this year.

Recently, a demonstration of the set in operation was given on board the yacht " Navigator " on a trip down the River Thames. This showed that strict attention to the simplification of electrical and mechanical design and the use of miniature components wherever possible have enabled a radar to be produced which is less than half the size of any other set yet available. Designed to meet the essential specifications of the Ministry of Transport, it fulfils the three major requirements of radar in all respects; as an anti-collision device, as an aid to navigating river channels and congested areas, and as a position indicator.

By producing the equipment in four compact units, installation problems are reduced, both practically and economically, and maintenance is speeded up and simplified; an important point where a quick turn-round is essential to the shipowner.

Details of Equipment

The Decca Radar comprises four units. The scanner system, a unique feature of which is the use of separate transmitting and receiving aerials, has mounted immedately beneath it, the modulator unit, together with the early stages of the receiver. This unit, which is of a plug-in type, is contained in a robust weather-proof housing. The complete scanner and modulator assembly is rotated by the drive unit immediately below. The scanner assembly is suitable for mounting on a bracket from any part of the ship's structure or on a tubular alloy mast. Connected to the scanner unit by a flexible cable system, is the receiver unit which also acts as a distribution point for the various circuits. The receiver is designed for bulkhead mounting in either the chart house or on the bridge. It is extremely compact, contains no operating controls and can therefore be placed in any convenient position. The output of the receiver unit goes to the P.P.I. display which is an extremely simple and compact unit, designed to mount either on the bulkhead, the chart table, or on its own pedestal on the bridge of the ship. The P.P.I. unit contains only the essential circuits that have to be immediately associated with the cathode ray tube and therefore a great degree of compactness and simplicity has been achieved. All controls in normal use during minute to minute operations are accommodated beneath a hinged flap. The cathode ray tube used is 5-in. diameter but this is magnified by liquid lens to the equivalent of a 10-in. tube.



Decca Radar Display Unit.

The ranges provided on the Decca Radar are half-mile, 1 mile, 3 miles, 10 miles and 25 miles. The half-mile range is remarkable for its definition and for the minimum range performance which is better than 25 yards. The Decca Radar can therefore claim a performance of 25 yards to 25 miles.

The fourth unit is the generator unit, designed for housing in the engine room or in any other convenient position. It includes automatic start facilities.

Low Initial Cost

This new radar will shortly be available at a selling price of £1,500 in the United Kingdom, a price that is considerably lower than that of any marine radar yet produced. The installation and maintenance costs are also expected to be correspondingly less than those normally experienced with marine radars. The fact that it has been possible to design a set of high performance, robustness, and simplicity in construction and operation, for which nothing has been sacrificed except cost, is a remarkable tribute to British engineering ability and enterprise.

The Decca Navigator Company believe that marine radar is complementary to the Decca Navigator System. Radar can provide information that will prevent collisions; it can also be used as a navigational aid in narrow waters, and where sea marks and land marks are within range. The Decca Navigator System fixes the position of the ship with an accuracy and precision unequalled by any other aid, over great areas of coastal water and sea. The instruments together provide an unequalled combination of radio aids which should do much to reduce the hazards of marine navigation and mprove the economy of marine operations.

The Construction of Harbours

An Article for Students and Junior Engineers

By STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

THERE are three main types of harbours, such as (1) natural ones, not fully exposed to the open sea; (2) sheltered river and canal inland harbours; and (3) artificial ones on exposed coasts and large lakes.

Most harbours are used for commercial purposes, but there are harbours of refuge for large ships and fishing fleets, and also those required in connection with Government Dockyards. With regard to natural harbours, these are numerous, consisting of headlands converging towards one another, with more or less narrow entrances between high headlands and cliffs, leading to a sheltered expanse of water; also coral reefs fringing a long coast line or islands, forming more or less deep water lagoons, with entrance gaps between the reefs.

River and canal inland harbours and ports may or may not be near the sea, some are so much as 30, 40 or 60 miles inland; they are usually situated at or near a town, and the river channels are often tortuous, and in some cases may require training walls, while the entrance at the mouth of the river if narrow, may require protection against heavy seas and shoaling by the construction of breakwaters.

Usually a considerable amount of dredging is required to keep the main channel navigable at all states of the tide.

Canals to inland ports require locks at intervals which delay the passage of vessels, the speed of which must also be reduced to avoid scouring of the canal banks. At intervals the canal is widened to allow ships proceeding in opposite directions to pass one another, this involves a system of signalling.

Artificial harbours are those formed by breakwaters projecting into the sea on an exposed coast, or in large lakes, the breakwaters being more or less curved to enclose a large area of water, and having one or two entrances, in the latter case, the breakwater between the entrances is known as a " detached mole." Harbours of this type may be constructed either for commercial purposes, or as harbours of refuge, and also for Government dockyards.

The chief object of their construction is to obtain a large area of deep water at all states of the tide, to give free movement and shelter for a large number of ships, and reduce the heavy cost of dredging that is necessary in river harbours and estuaries; also to provide turning and swinging circle areas of 1,500-ft. or more in diameter, and areas for " trots " with fixed moorings and buoys.

All harbour entrances require lighted beacons or lighthouses, and in some cases in addition two lighted beacons are erected where possible on the land opposite the entrance, spaced several hundred feet apart, one behind the other in alignment with the centre of the entrance.

The edges of the main channels through or round the harbour bar and the river navigable channels will require to be buoyed by can-shaped, black and white chequer painted buoys on the port or left side, and by conical red painted buoys on the starboard or right side of the ship as it enters the harbour. The buoys are numbered from the entrance inwards, beginning with No. 1, for the first can buoy on the port side, and No. 2, for the first conical buoy on the starboard side, and so on alternately up the harbour entrance or river, the port buoys bearing odd numbers, and the starboard even ones.

Important channel and mooring buoys are lighted by oil burning lamps, or compressed gas, as the yellowish light of these penetrates fogs better than electrically lighted ones, but the latter are also used.

It is not usually necessary to buoy straight lengths of river channels continuously, but all bends require them, and the ends of all harbour bars, and shoals both inside and outside the river.

Tide gauges painted in large white figures will be required on the breakwater walls at the entrance.

The heads of breakwaters or a prominent portion of the harbour near the entrance should be provided with masts for signal flags and storm cones, a radar tower and control room may also be required for guiding ships in foggy weather.

Lighthouses at important ports are also supplied with sirens, worked by compressed air or electric power, and in some small ports bells and signal guns are installed, rocket-firing apparatus should be available at all ports exposed to the sea. A deposit area for dredgings not used, will require to be buoyed by conical buoys painted with black and yellow vertical stripes, in deep water, at some miles outside the harbour; they may be anchored, or the cables may be held by cast iron or concrete block sinkers.

Siting of Harbours

It is not advisable to site a harbour at the mouth of a river that cannot be navigated by ships, as the harbour bar will tend to increase in size, unless swept away by strong currents, and the harbour will be liable to silt up rapidly, entailing considerable dredging. In some cases where this has been done, a lock suitable for barges and small craft has been constructed at the mouth of the river where it enters the harbour, the gates of the lock being fitted with sluice valves. At low tide the sluices are opened to clear the channels of mud and sand, but the accumulation of mud alongside the wharf walls is not thus removed. In such harbours the land side becomes dry at low water, and vessels are grounded, but this enables a " hard " or sloping platform of stone or concrete to be constructed, and also a timber-built grid anchored to concrete or rock to be built, so that the hulls of fishing vessels and other small craft may be repaired, scraped, tarred or painted.

To clear tidal basins of mud, perforated pipes have been laid on the bed of the basin, and water under high pressure has been forced into them to stir up the mud during a falling tide, it is thus carried away on the ebbing tide, but this may have the effect of increasing the harbour bar, involving additional dredging, unless the currents are strong.

In such basins the berths for ships alongside the wharf walls must be kept dredged, so that vessels will not be grounded at low water.

When it is decided to site an artificial harbour with breakwaters on an exposed coast, and a suitable site has been selected, which should be convenient to a town, railway, and fresh water supply, the first step is to obtain copies of old charts and maps, in addition to the latest ones, so that alterations in the coast line, the beaches, positions and sizes of shoals, and the depths of soundings may be examined and compared.

Form the data thus obtained it can be shown how the shoals have increased or decreased in size, altered their positions and shapes, and whether there is a tendency for the area on the site of the proposed harbour to silt up.

Soundings over the area to be occupied by the harbour will require to be taken either by casting the lead, sounding tubes, or by echo-sounding apparatus in a vessel, and reduced to L.W.S.T. level, the period of slack tide at L.W. is a suitable time to do this.

The direction and velocity in knots of the tidal currents at various states of the tides should also be obtained by a rotator apparatus trailed from an anchored boat.

Particulars of the direction and velocities of the prevailing winds and storms, also the height of waves and the geology of the sea bed and coast will also be required.

Should the sea bed consist of mud and sand, then prickings or borings will be necessary to test the thickness of the strata, so that the amount and character of the materials required to be

The Construction of Harbours—continued

dredged for the proposed depths at L.W.S.T. plus 1-ft. tolerance may be ascertained.

The minimum depth of water at L.W.S.T. required in the harbour will depend on the types of ships for which it is intended, but consideration should be given to future requirements as the tendency is for vessels to increase in draught, a depth of 30-ft. may be sufficient in the first instance, but provision should be made in the depths of the foundations of wharves and breakwaters, for an increase in the depth by dredging to 34-ft. or 36-ft. a clearance of at least 2-ft. should be allowed between the bottom of a ship and the sea bed.

As the construction of breakwaters at right angles or inclined to the shore line involves heavy expenditure, it may be necessary in some cases to have a small working model made of the proposed harbour based on the latest charts, using for the sea bed a fine mud and sand mixture to find what effect the breakwaters will have on the currents and where accretion and scouring action on the sea bed are likely to occur.

The general effect on currents running parallel to the coast line when breakwaters are constructed is illustrated by the sketches Figs. 1 and 1a for a single breakwater or groyne, and 2 and 2a for two breakwaters, where there are slow eddies there will be silting, and with rapid ones near the entrances there will be scouring action, while on the shore side of the harbour, silting will take place, because of the slow currents, for this reason it is better to project piers and jetties into the harbour from the shore wharf, than to have a continuous wharf for ships to lie alongside.

Breakwaters

When all the particulars required have been ascertained and the proposed site is considered suitable, the working plans and drawings of the proposed works may be proceeded with, the question will then arise as to the most suitable types of breakwaters to be designed; this will depend largely on the nature of the sea bed. If there is rock or chalk about 1-ft. below the mud and sand, then breakwaters formed of concrete blocks laid horizontally or inclined at an angle of about 60 degrees to the horizontal, or reinforced concrete caissons filled with concrete will probably be the most suitable; but should there be several feet of soft material overlying the surface of the rock and the latter is very irregular, the block superstructure may be founded on a low rubble stone mound levelled on the surface, and a wide berm should be provided on each side to guard against scour.

If the sea bed consists of a considerable thickness of mud, sand, and gravel, then a rubble stone mound will be the most suitable, the top of the mound should be carried up to about 10-ft. above H.W.S.T. level, and may be capped with a concrete block or mass concrete wall. The body of the breakwater mound may be formed of gravel and stone dredgings, with layers of larger stones near the slopes, and heavy stones and concrete blocks laid irregularly above L.W.S.T. to form a surface layer and break up heavy seas. Slopes of 2 and 3 to 1 vertical, are usually given on the outside and 1½ or 2 to 1 on the inside, and the top width should be at least 20 feet.

In some cases the rubble mound is constructed up to a height of from 10 to 12 feet below L.W.S.T. and surmounted by a solid concrete breakwater or one formed of concrete blockwork. When this is done the surface of the mound should be covered with layers of small stones, and coarse gravel to fill the interstices, and levelled by divers or by trawling a heavy rail or steel joist over the surface. In some cases a layer of concrete is spread over the surface, and in others a platform of conrete in bags is constructed.

When measuring the volume of a rubble mound breakwater, about 25% should be deducted for interstices, and 17% added to provide for its settling several feet into the sea bed.

Figs. 3 and 4 show cross sections of two types of breakwaters for similar depths of water, and how they effect heavy seas breaking against them, also the normal pressures on the sea bed due to the structures, due allowance having been made for the submerged portions being waterborne; the maximum normal pressures under the main body of each breakwater is over 3 tons per square foot, while outside the breakwaters the water pressure is only 1.14 tons per square foot, so that in mud and sand there will be a considerable tendency for the breakwaters to subside; this will be accentuated in heavy storms, for then the pressures under the solid wall portions in Fig. 4 may amount to so much as 6 tons per square foot under the blockwork on the harbour side, and 1.3 tons per square foot uplift on the outside, under wave pressures of 2 tons per square foot for a height of 10-ft.

Fig. 3 consists of a rubble stone mound, with a small mass concrete superstructure containing 10 cubic yards per lineal foot and stone rubble 128 cubic yards, a total of 138 cubic yards.

The storm waves of oscillation change to waves of translation as they approach the shallow water on the slopes of the mound, and so break on the slopes and tear down the surface, so that large stone and concrete blocks, weighing from 30 to 50 tons and more are required to protect the mound.

The water pressure on the sea bed will be continually changing according to the heights of the waves and tides.

Fig. 4, shows a low mound of rubble stone with a concrete block breakwater, containing 47 cubic yards per linear foot and a rubble mound of 34 cubic yards, or a total of 81 cubic yards; so that taking similar prices for the rubble stone in each case, and also for the concrete, then this breakwater will be the least expensive, but being more difficult to construct, and when the cost of the block making plant and titan crane are included, it may be well the more costly.

The sea waves of oscillation in this case surge against the breakwater, causing heavy pressure, it may be so much as 2 or 3 tons per square foot over a limited area, and are then thrown upwards the air between the blocks is compressed, and as the waves recede, the air escapes and forces the blocks outwards unless they are well keyed or dowelled together.

The advantage of this form of breakwater over that of a rubble mound is that vessels can be moored alongside, and the area of the harbour with the required depth of water is not so much reduced.

The type of breakwater to be built will also depend on the materials readily available at no great distance from the site; the sand and gravel may be obtained from dredgings, which will require to be washed and graded, and all vegetable matter removed, or it may be necessary to transport it by sea or land from some distance, this also applies to large stones several tons in weight.

When deciding on the weight of the blocks to be used on the outside of mound breakwaters it should be borne in mind that stone blocks will be reduced in weight to 60% of their dry weight, and concrete blocks to 55%, due to their immersion in sea water.

With regard to the maximum height of waves striking breakwaters, the heights so far observed range from 15 to 30 feet, with spray up to 120-ft.

In a few harbours the breakwaters are separated from the shore and the gap is bridged by an open viaduct, this assists in scouring the harbour, but in stormy weather produces rough harbour water and a swell. A wave trap may be required in the harbour opposite the entrance, if this is situated facing the direction of the heaviest gales, but that position should be avoided where possible.

Working Area for Contractor

A large working area for the Contractor will be necessary above the forshore for use as a dumping ground for materials, also for roads, railways, cranes, concrete mixing machines and blockyard with a travelling gantry crane.

A cantilever titan crane for laying concrete blocks may also be required to be erected there, offices will be necessary for the Engineers and Contractor, shelters, canteen and latrines for workmen, also workshops and storehouses for cement, tools and diving gear.

Entrances to Harbours

The width given to harbour entrances varies considerably from 400 to 1,400 feet. At Colombo there are two entrances of 550 and 630 feet respectively, and at Dover, two of 650 and 740 feet, the usual widths given vary between 650 and 800 feet, they depend upon the rises and ranges of the tides, and should be sufficiently wide to reduce the velocity of the water passing through them on the flood and ebb tides, and give sufficient width for vessels to stand clear of the breakwater heads in rough seas, and strong currents across the entrance.

The Construction of Harbours—continued

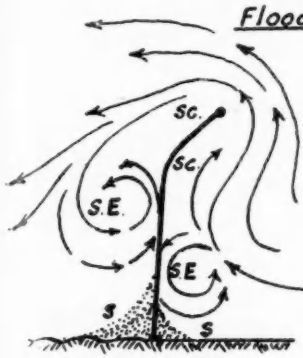


Fig.1.

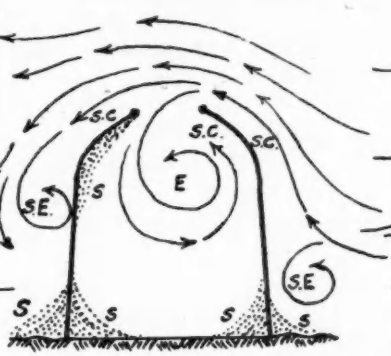


Fig.2.

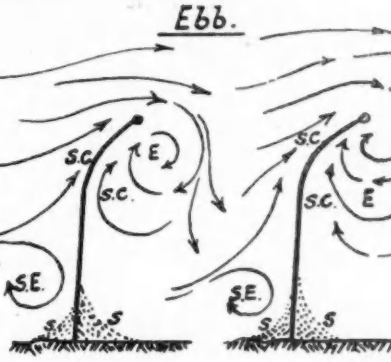


Fig.1A.

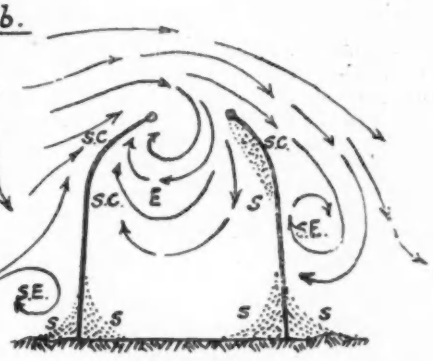


Fig.2A.

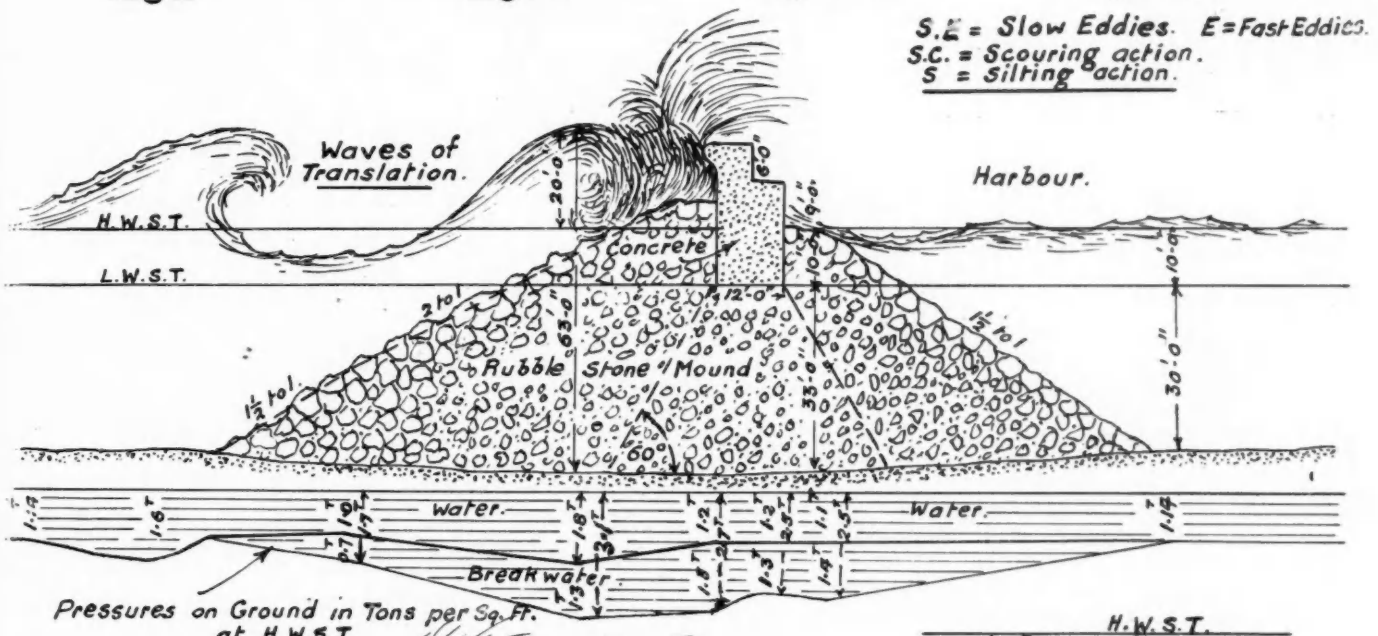


Fig.3.

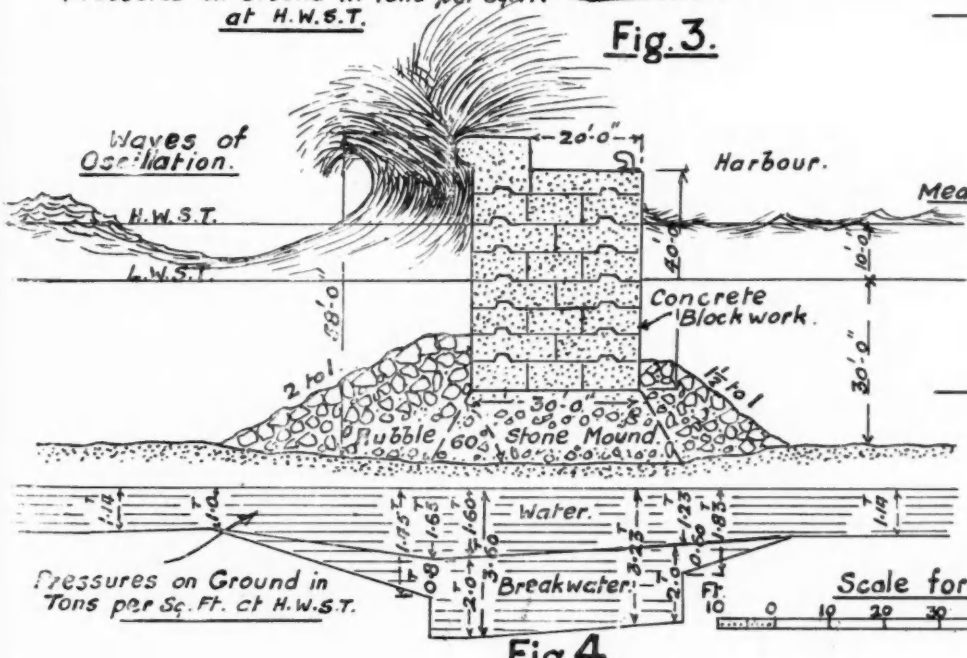


Fig.4.

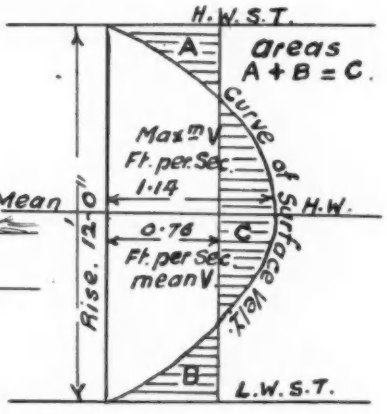
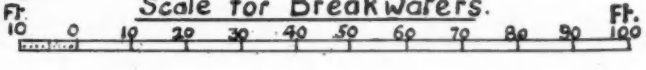


Fig.5.



The Construction of Harbours—continued

The widths of entrances at H.W.S.T. for river harbours and tidal basins so far constructed is 1-ft. of width per 0.11 to 0.25 acre area of harbour, the average for 9 harbours being 1-ft. per 0.163 acre; and for harbours exposed to the open sea, the entrance width varies from 1-ft. per 0.92 to 1.16 acres, and with double entrances to 1-ft. per 0.431 to 0.545 acre.

In most harbours there is only a single entrance, but two are introduced in some for the purpose of preventing the harbour from silting up, and also to provide an alternative entrance for vessels in stormy weather, or to enable them to avoid strong currents across one of the entrances.

Double entrances also reduce the velocities of the currents passing through them on the flood and ebb tides; these can be calculated approximately as follows, viz:—assuming the water area of a harbour is 600 acres × 43,560 sq. ft. = 26,136,000 sq. ft. and that the rise of tide between L.W.S.T. and H.W.S.T. is 12-ft., then for a length of 1-ft, a total volume of 313,632,000 cub. ft. will pass through a 450-ft. entrance 42-ft. deep at H.W.S.T. in about 6 hours. The water area of the entrance will be 450-ft. x 42-ft. = 18,900 sq. ft. or cub. ft. per lin. ft.

$$\therefore \frac{313{,}632{,}000}{18{,}900} = 16{,}594 \text{ cub. ft. or about } 2{,}765 \text{ cub. ft. per}$$

hour or a velocity of 0.76-ft. per second, the maximum velocity will occur at half or mean tide and will be equal to 0.76 x 1.5 = 1.14-ft. per second, and 1.14 x 0.59 = 0.67 knot of 6,080-ft., one knot = 1.68-ft. per second.

The velocity of the water passing through the entrance on the flood and ebb tides reaches its maximum at half tide and assumes a parabolic curve; the whole body of water in the harbour is in motion, the velocity at the bottom being about 1/4 to 1/3 of that at the surface, due to ground friction, and weight of water.

To find the surface velocities at various states of the tide, construct a parabola as shown in Fig. 5, making the base equal to the rise of the tide, draw a line parallel with the base on the parabola side, and at a distance from it equal to the average velocity in feet per second, make area C = areas A + B then the maximum velocity will be equal to the mean V x 1.5.

There may be much stronger currents flowing across the entrance to a harbour than those passing through the entrance, and the former are the dangerous ones for shipping.

Flood tides scour the channels because of the greater velocity of the water, and deposit the silt on the sandbanks, and harbour bars where the currents are slower; while ebb tides scour the sandbanks because of the reduced depths of water, and deposit the silt in the channels.

As regards the velocities of the currents, if M = the mean velocity in feet per second; S = the surface velocity, and B = the bottom velocity, then $B = (\sqrt{S}-1)^2$ $M = \frac{S+B}{2}$ or $M = \frac{S+(\sqrt{S}-1)^2}{2}$

Scouring action varies directly as the square of the velocity, and as there is usually a considerable amount of bottom scour at the heads of breakwaters, provision should be made for this, by placing either a concrete apron or concrete blocks in the sea bed round the heads of mass concrete or concrete block breakwaters.

Areas of Harbours

The areas of open water in harbours varies considerably according to the purpose for which they are intended; in those exposed to the sea, and used for commercial as well as shelter harbours they may run up to 4,316 acres as at Durban, where the entrance is 600-ft. wide, while the area at Dover is 600 acres and at Colombo 643 acres, but most commercial harbours are much less, with the exception of navigable river ports which are usually long ones, one or both banks of the river being occupied by private or Port Authority docks, wharves, jetties, coal shipping staithes, storage for ores and phosphates, timber yards, workshops and engine works, goods depots, grain silos, ship building slipways, repairing slipways, customs house, transit sheds and office buildings, petrol and oil tanks, etc.

Railways and Roads

It is advisable when siting a harbour exposed to the sea, that it should be near a town, and that railway and road communications will be available, and also a fresh water supply.

If the town stands at a much higher level than the harbour wharves, it may be possible to extend the railway and main road down to the wharf level through cuttings or in a tunnel.

A considerable number of railway sidings will be required at the back of the wharves and transit sheds, and also a road and railway on each side of the transit sheds, with cross-over railways between the sheds, turntables may also be necessary, and railways for travelling wharf cranes which are usually sufficiently wide to allow one or two lines of railway for goods trucks to pass under the cranes, these are either hydraulic or electrically driven and are capable of lifting 3 tons at radii of 55-ft., 65-ft., up to 80-ft., and are level luffing. Electric travelling cranes for lifting much heavier loads, such as locomotives are also used on wharves, and at dry docks.

Wharves and Jetties

At the shore side of the harbour, a wharf wall will be required with deep water alongside, the top of the wall being carried up to about 6-ft. above H.W.S.T. level; the filling and area at the back of the wall being formed to that level, well rolled and consolidated.

On this area the various buildings, such as general storehouses, workshops, bonded stores, customs house, fire engine station, harbour offices, passengers' waiting rooms, customs shed, latrines, railway station; pilots, police and foremen's offices, workmen and divers' gear sheds, canteens, etc.; and possibly electric and hydraulic power stations, will require to be erected. In some of these buildings, the foundations may require to be piled.

Areas near one of the breakwaters may be set apart for a lifeboat house and slipway, and a slipway for repairs to tug boats and dredgers, also for petrol and oil fuel tanks and an oil pumping station; a dry dock may also be required with pump house. Another portion will be required as a storage ground for buoys, chain cables, anchors, cast iron and concrete sinker blocks.

At an inclination to the wharf, or at right angles to it, according to the shape of the harbour, solid or piled jetties will require to be constructed parallel to one another and with spaces between them from 350 to 550 feet wide; the lengths of the jetties may be up to 1,000 feet or more; in some ports the lengths are so much as 1,500, 2,350, 3,700 and 8,200 feet, this depends upon the class and number of vessels using the harbour; most merchant ships are between 300, 400, 500 and 700 feet long, and the beams are about $\frac{1}{8}$ of their length.

The width of the jetties may vary between 250 and 500 feet according to the widths of the transit sheds, and allowances for railways, roads and crane tracks.

A super load of from 8 to 12 cwts. per square foot should be provided for on the wharves and jetties.

An oil fuel jetty will also be necessary with proximity to the oil fuel storage tanks, and with deep water alongside so that tanker vessels can discharge at all states of the tide.

These ships vary in length between 350, 436, 600 and 708 feet, and have loaded draughts of from 26 to 29 feet; the amount of oil carried averages about 20 tons per lineal foot of vessel.

Turning and Swinging Circles, etc.

Turning circle areas will be required near the heads of the jetties, about 1,000 feet in diameter, and also a swinging circle berth from 1,500 to 2,000 feet with a mooring buoy at the centre, so that the ships' compasses may be tested; this should be situated out in the harbour, clear of the entrance, and of the movements of vessels to and from the jetties.

On one or both sides of the harbour parallel to the breakwaters, and clear of the fairway, ground moorings or "trots" in single or double line will be necessary for ships awaiting jetty berths

The Construction of Harbours—continued

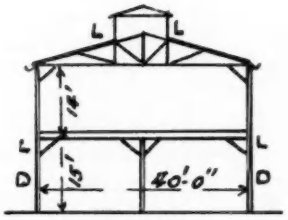


Fig.6.

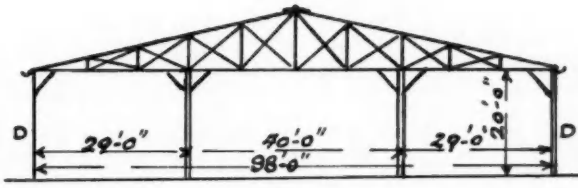


Fig.7.

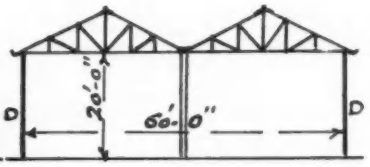


Fig.8.

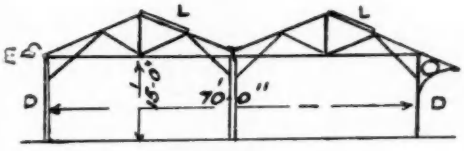


Fig.9.

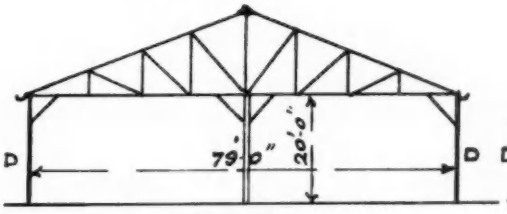


Fig.10.

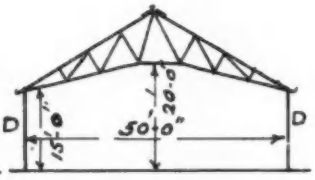


Fig.11.

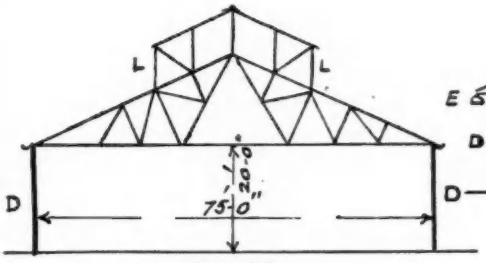


Fig.12.

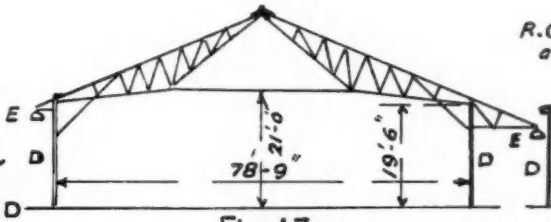


Fig.13.

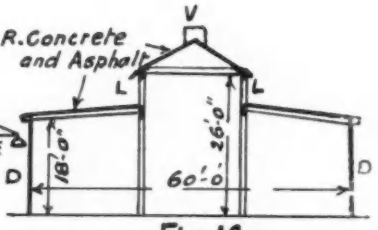


Fig.14.

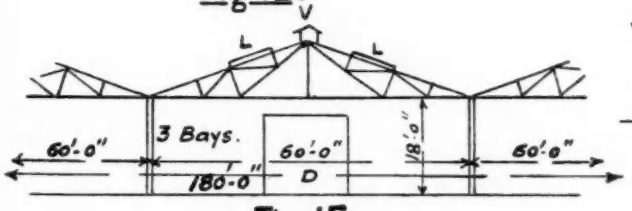


Fig.15.

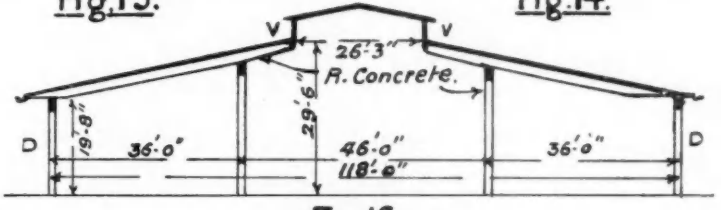


Fig.16.

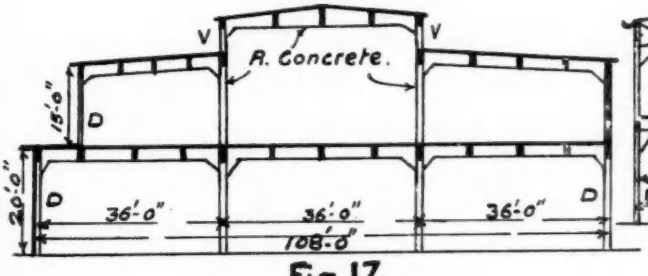


Fig.17.

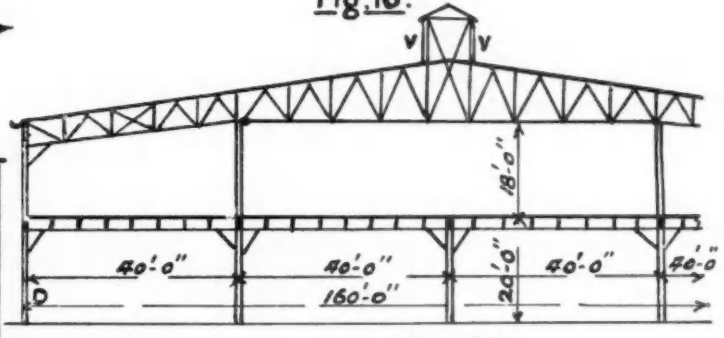
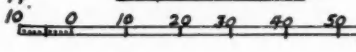


Fig.18.

Reference.

D = Doors.
L = Lights.
V = Ventilators.
E = Electric Lights.

Scale for Sheds.



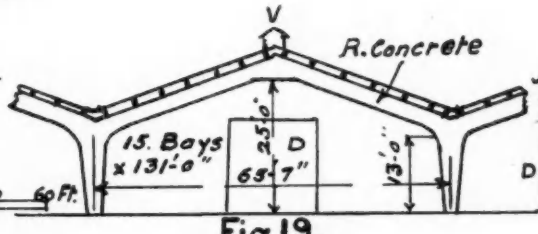


Fig.19.

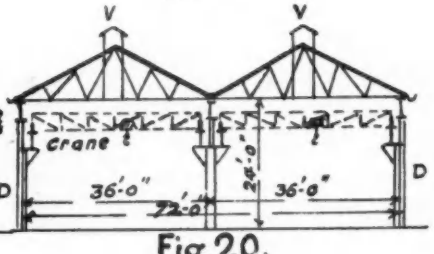


Fig.20.

The Construction of Harbours—continued

Each mooring buoy is attached by a chain cable to a shackle and swivel on the head of a solid steel screw pile 6 inches or more in diameter, screwed 10 or 12 feet into the harbour bed by a power capstan on the deck of a vessel having a 7-ft. square well in the centre, a temporary pile length being attached to the screw pile for the purpose.

Assuming a screw pile anchorage sunk 10-ft. into stiff mud, the shaft of the pile being 6 inches diameter, and the blade of the screw 4-ft. diameter, the amount of mud resisting a vertical pull will be in the form of an inverted truncated cone, with an angle of rupture of 60 degrees to the horizontal round the periphery, the base of the cone at sea bed level will be about 15-ft. in diameter, and the bottom 4-ft. diameter then the resistances will be as follows, viz.: weight of 30-ft. of water at L.W.S.T. on an area 15-ft. diameter = 151.7 tons; mud at 112 lbs per cubic foot = 39 tons, screw pile = 1 ton, side or internal friction of mud at 1 cwt. per square foot = 16.8 tons, suction at bottom of screw blade at 1 cwt. square foot = 0.6 tons, a total of 209.1 tons, as against a possible pull of 80 tons, or a factor of safety of about 2.6.

As regards the angle of rupture, for damp sand it varies from 52° to 60° and for dry sand it is about 64° while the shearing strength of wet sand is about 8 lbs. per square foot, damp earth = 18 lbs., soft clay 112 to 156, and stiff clay 380 to 448 lbs. per square foot. Under the strain of a pull on the screw pile, the first cracks in the soil will appear as radial fissures, allowing the water to enter and considerably reduce the resistance, so that the friction of the mud has been taken at 1cwt. per square foot.

Should the bed be of rock or other hard material, the mooring chain of the buoy is fixed at the lower end to a swivel shackle on a steel ring, the ring having four chains which are attached by shackles to steel rods buried at each corner in a square block of mass concrete sunk in the ground.

Assuming a concrete block 20-ft. square and 4-ft. thick sunk in a sea bed of stiff clay, and that the block is not waterborne, the resistances to uplift will be as follows, viz.: weight of 30-ft. of water on block 342.8 tons, weight of block at 16 cubic feet per ton = 100 tons, side friction at 5 cwts. per square foot = 80 tons, and bottom suction at 1 cwt. per square foot = 20 tons; a total of 342.8 tons, and a factor of safety of 6.7 against a pull of 80 tons.

If waterborne the resistances will only be 55 per cent. of the weight in air of the block, thus reducing it to 55 tons, in which case a concrete block 30-ft. square and 4-ft. thick will be required weighing 240 tons in air, and 132 tons in the water.

The pull on the chain cables of the buoys from a ship moored to fore and aft buoys by hawsers, may be so much as 80 tons or more per buoy, during a heavy gale, depending on the size of the vessel.

Allowance should be made in the lengths of the chains for the catenary sag, and rise of the tide.

Miscellaneous

A boundary wall or unclimbable fence at least 8-ft. high will be required to embrace the land area occupied by the Port or Harbour Authority with entrance gate and police office inside; in some cases a weighbridge and hut are also installed.

The harbour yard, wharves and jetties should be well electrically lighted, and the wharves and jetties supplied with oil, petrol, fresh water, and electric light and power mains, capstans will require either electric or hydraulic power, and will be situated at the jetty heads, and at intervals along the lengths to deal with vessels and railway trucks, and also at the railway sidings. Bollards, ring bolts, fairleads, and ladders are necessary on the wharves and jetties.

Sewage, where possible should not be discharged into the harbour but conveyed in sewers to the outsides of the breakwaters at the shore ends, then carried in cast iron pipes covered with concrete out to some distance below L.W.O.S.T. The pipes should be supported on two piles with cross beams at each joint, usually every 9 or 12 feet, the outlet of the pipe being protected by a metal grid and flap valve.

Fire Services

It is important that an efficient fire service should be provided in connection with the wharves, jetties, and transit sheds, either by fresh or salt water, if the latter, a special pumping station will be necessary, drawing water by centritugal pumps from the harbour, and distributing it by piping having valves and hose connections at intervals, to the various points at which it may be required; a portable petrol motor driven fire engine, and a harbour fire float may also be necessary.

In cold climates a salt water fire service is preferable to a fresh water one, as it will not freeze so readily.

In some cases an arrangement of pipes on the ceilings of sheds and on the tie bars of roof trusses is used to distribute through sprinklers, either sprays of water, or foamite and carbon dioxide over the cargoes, the sprinklers being controlled by valves in suitable positions; portable fire extinguishers should also be installed in various parts of the sheds.

Cranes and Lifts in Transit Sheds

Overhead travelling cranes are not usually installed in transit sheds, but in some cases they have been to handle heavy goods; most of the handling is done by manual labour using two-wheeled hand trucks, or electrically-driven ones; the hoisting and stacking of cargoes is usually carried out by mobile or runabout electric cranes and hoists capable of lifting up to 2 tons, and depositing goods to a height of from 10 to 14 feet.

Some of these portable cranes are capable of lifting up to 15 tons weight. The mobile cranes, trucks and hoists are operated by electric motors connected to batteries which require recharging at intervals.

Vertical lifts and elevators installed in some transit sheds for dealing with the transit of goods to upper floors are operated by 5 h.p. electric motors.

Transit Sheds

The dimensions of transit sheds or "go-downs" as they are termed in some Eastern ports, vary considerably according to the requirements of the port, and the character of the goods to be dealt with.

In most ports these buildings have a ground floor only, but in cases in which the jetty or wharf area is constricted, buildings with one to three stories high have been erected.

Ground floors are usually from 15 to 20 feet high to the ceiling or the roof tie bars, and 12 to 15 feet high in upper floors. The widths of the sheds vary from about 40-ft. to 160-ft. and more according to the widths of the wharves or jetties, but it is advisable that they should not exceed 150-ft. for easy handling of goods; the lengths of the sheds may be several hundred feet up to 450-ft. but some have been constructed 1,500-ft. long.

In some Eastern ports the sheds are constructed of timber and covered with corrugated steel or asbestos cement sheets, others are built of brick, stone, or concrete, and the roofs are covered with tiles or slates on boarding, steel and asbestos sheeting being also used, but more modern sheds are constructed entirely of reinforced concrete, with flat roofs on a slight slope and coated on the surface with asphalt 1-in. thick.

As transit sheds are generally in very exposed positions, the roofs should have a low pitch, so that coverings of galvanised corrugated steel sheets, asbestos cement sheets, and reinforced concrete, are the most suitable materials to use.

The rise given to the roof trusses for sheeting is usually about $\frac{1}{8}$ of the span, for slated ones it is 1/5, and for tiled roofs 1/3 of the span, these latter higher pitches are given to prevent the wind lifting slates and tiles.

The most vulnerable points on buildings as regards wind pressure are overhanging eaves and gable ends, verandahs, and continuous roof lantern lights and ventilators; as wind acts similarly to water in motion, and when obstructions are met, strong eddies are formed, their being also partial vacuums on the lee side, which reduces the resistance of the building to the pressure, so that roof trusses should be well anchored to the walls or stanchions,

The Construction of Harbours—continued

merely bolting them to the timber wall plates is not sufficient, unless the plates are securely anchored by long bolts to the walls.

When steel roof trusses are supported on walls, the main tie rods may be of round or bar steel in section, but when carried on stanchions, they should preferably be of steel angles, as they are liable to come under compression from the lateral wind pressure on the building; knee braces should also be fixed between the main tie bars and the stanchions.

The weights per square foot horizontal area of steel roof trusses 10-ft. apart, having a rise of 1/8 of the span, and covered with steel sheeting, is for 30-ft. spans, 3 lbs. per square foot and for each 10-ft. extra span, add 0.75 lb. per square foot so that a span of 100-ft. will weigh about 8.25 lbs per square foot.

The weight of trusses on the inclined area of the roof = the weight on the horizontal × 0.9 and the weight on the horizontal area = the weight on the inclined one × 1.12.

In calculations for the strength of roof trusses, a horizontal wind pressure of 30 lbs. per square foot on the vertical area will be sufficient to allow in most climates, but this may reach from 40 to 50 lbs. per square foot where tornadoes and heavy gales occur.

The weight of snow may be taken at 5 lbs. per square foot of inclined area, but in Canada 10 lbs. is provided for on sloping roofs, and so much as 40 lbs. on flat ones.

Condensation inside the sheds on the walls and under the roof sheets is considerable in some climates; to overcome this, a layer of varnish is applied to the undersides of the sheets, and dry powdered cork is sprayed on to absorb the moisture, or the sheets are laid on 1¼-in. thick, tongued and grooved boarding, to provide for fixing the sheets with nails, the steel purlins having a timber filling; but to reduce the weight of this, ¾-in. boarding may be used, and 3-in. x ¾-in. thick timber battens nailed to it at 5-ft.—6-in. centres for 6-ft. sheets.

The live loads to be provided for on the ground floors of transit sheds should be from 300 to 400 lbs. per square foot and on the upper floors from 200 to 250 lbs. while on flat concrete roofs that may be loaded, 340 lbs. per square foot should be provided for.

Weight of Roofing Materials

The weights of roofing materials in pounds per square foot of inclined areas of roofs, are as follows, viz.: galvanised corrugated 3-in. x ¾-in.) steel sheets 6-ft. x 3-ft. and 18 S.W.G. thick = 2.46, No. 16 S.W.G. = 3.0 corrugated asbestos cement sheets (6-ft. x 3-ft.) with 3-in. x ¾-in. corrugations and $\frac{3}{16}$ thick = 2.27; these sheets are rather brittle, and to provide for the weight of a man on a roof, the purlins should be spaced 2-ft. 9-in. apart. Asbestos cement sheets (6-ft. x 3-ft.) with 6-in. x 2-in. corrugations and ¼-in. thick weigh 2.82 lbs per square foot the purlins for these may be at 5-ft. 6-in. centres.

Steel and abestos cement sheets having 3-in. corrugations are laid with a 3-in. side lap, and 6-in. end laps, so that 17 per cent. should be added to the weight as laid to allow for laps and fastenings, and with 6-in. side laps 25 per cent. should be added.

Tarred felt is sometimes laid on the boarding this weighs 0.56 lbs. per square foot No. 4 thickness, and 0.45 lbs. per square foot for No. 3.

Slating 1st quality weighs 6, and 2nd quality 8 lbs. per square foot.

Timber boarding 1¼-in. thick = 3.75, 1-in. thick = 3, and ¾-in. = 2.25 lbs. per square foot. Asphalt 1-in. thick = 13 lbs. per square foot.

A 3-in. thick reinforced concrete roof, with 1-in. of asphalt will weigh 50.5 lbs. and including concrete purlins 66 lbs. per square foot.

Steel angle purlins 10-ft. span and 5-ft. 6-in. apart weigh 1.2 to 2.2 lbs. per square foot while timber purlins 6-in. x 3-in. = 0.82, and 7-in, x 4-in. = 1.3 lbs. per square foot.

Sliding Doors

The sliding doors on each side of the sheds facing the wharf frontage, are usually in the centre of each bay, but some are more or less continuous, sliding past one another, and suspended from overhead rollers travelling on bar rails; bottom rollers with grooved rails are not advisable, as the groves are liable to be choked with dirt.

The bottom of the doors should be provided with a steel T, the web of which runs in a narrow steel groove embedded in concrete, to avoid a wide gap at floor level.

Some large doors are operated by gearing on the inside, in which case, a small man door is required for access into the shed.

The doors may be constructed of timber with ¾-in. thick, tongued and grooved boarding; or they may be formed of steel angles and channels, covered with 1/8-in. thick steel sheets galvanised corrugated steel or asbestos cement sheets.

The weight of a 15-ft. square steel-framed door, including 1/8-in. thick steel plate will be about 2,700 lbs. or 12 lbs. per square foot while a steel roller shutter door 25-ft. wide and 14-ft. high mounted on a 12-in. diameter overhead roller, will weigh about 3.3 lbs. per square foot; this type of door is more suitable in sheltered positions, as with a wind pressure of 30 lbs. per square foot, that on this door would amount to 4.68 tons, and the door would require strengthening at the back with temporary steel stanchions, when the shutter is down.

Staircases, Windows, Ventilators, etc. in Sheds

Staircases will be required in sheds that have upper floors, having 12-in. treads and 9-in. risers, also chutes for cargo, and trap doors to openings in floors, and combings to open hatches.

The use of skylights, in roofs with thick wired glass, is not advisable, as they are liable to leak, and in hot climates the heat from the sun may ignite some cargoes.

Windows may be placed in the end walls, and over doors, and between them on the side walls, but the main lighting of sheds is usually by electric light.

Ventilators over doors and at the end of sheds, and also at the apices of roofs in the form of chimneys or lanterns will also be necessary.

Floors should preferably be of reinforced concrete, although timber floors are much used. Boarding for ground floors should be nailed to battens sunk flush in concrete to avoid spaces for rats.

A cold storage space and refrigerator machinery room may require to be provided in one of the transit sheds.

In fishery ports sheds will be required for sales, the curing of fish, ice block making, and refrigerator machinery, also stores for packing fish, fishing equipment, boxes, barrels, and salt store.

Types of Transit Sheds

Figs. 16 to 20 are sketches of the cross sections of various types of transit sheds that have been erected in some foreign ports, and show no uniformity in design, the materials used generally depend upon what can be obtained locally; but sheds constructed of reinforced concrete with more or less flat roofs have been built in recent years in both home and foreign ports; some of these have a ground floor and one or two upper floors with flat roofs and electric travelling cranes on the roofs on the wharf sides, the jibs of these cranes span either the wharves or the holds of ships.

There are hatches with combings and portable covers down the centre of the roof at intervals, and also in the centres of the crane tracks, through which goods are passed into the sheds, the upper floors being also provided with hatches under those in the roof, in addition to cargo chutes and staircases.

South Coast Radar Beacons.

" Ramark " beacons, developed by the Admiralty at the instigation of the Ministry of Transport, and with the co-operation of Trinity House, have been set up experimentally at St. Catherine's and Portland Bill lighthouses. The transmissions are received on the P.P.I. each time the vessel's radar aerial points to the beacon during its revolution, and take the form of a dotted line (St. Catherine's) and a dashed line (Portland Bill) giving bearings relative to the ship's head. The pick-up range of the two beacons is 12 and 14 miles respectively. For trial purposes they are time-controlled (40 seconds on and 20 seconds off) on the odd days of the month, and are operated continuously on the even days of the month.

Testing Integrated Barge Fleets

By ALLAN B. MURRAY.*

During the war years there was very little new construction of privately owned river barge transportation equipment. It is interesting to note that as new developments appear the integrated barge fleets are gaining favour.

To the best of the author's knowledge, the first fleet of integrated barges was built by the American Bridge Company in 1940. It consists of six barges having a combined capacity of about 53,000 barrels of oil. The fleet is set up two barges wide and three long, making a unit 585 feet long and 71 feet wide. Only the bows of the two forward barges and sterns of the two after barges are raked. All other ends are boxed, the total forming what closely approximates a large single barge.

Recently, two fleets have been built, each consisting of two barges of somewhat more than twice the capacity of the barges in the fleet of six above. These newer fleets have capacities of about 40,000 barrels and have total lengths of 480 and 490 feet, respectively. With this size, it is possible for the complete unit of two barges and towboat to negotiate the Ohio River locks without breaking up.

The small compact unit, which can lock without breaking up, certainly has advantages. However, it is known that a greater reduction of resistance per ton of displacement is obtained with larger fleets. In any case, important reductions of resistance are possible by eliminating the eddy drag between the barges.

Some time ago, a series of model tests was made at the Experimental Towing Tank in Hoboken, to find out just how much saving could be realised. With the permission of the client, the results of this investigation are outlined here. The tests compared a fleet of conventional barges with a fleet of integrated barges of the same dimensions. Fig. 2 shows the difference in design between conventional fleet and integrated fleet.

Test runs were made at a number of drafts with a water depth of 9 feet, and at a constant draft of 4 feet 6 inches with various water depths up to 9 feet. Resistance curves for fleets of 7-foot draft in 9 feet of water have been selected for illustration. Fig. 4 shows a reduction in resistance of 13 per cent. for the integrated fleet at 6 miles per hour. The dotted curve represents the available pushing ability of a typical towboat for this size fleet. This shows a gain in speed from 5.86 miles per hour to 6.12, or 4½ per cent. For upstream towing, against a current of 3 miles per hour, the net gain is 9½ per cent. In fact, it has been found that savings of cost per barrel of oil transported are almost proportional to reduction of barge resistance. In this case, we also have the further gain of increases of capacity.

It is difficult to assess the savings due to increase in speed because of such variables as towboat power, river current, total trip time. The savings can be more easily demonstrated by utilising resistance gains in increased cargo carrying. Fig. 5 has been prepared from the data to show the total resistance versus draft for both fleets at a speed of 6 miles per hour in 9 feet of water. This chart shows that the integrated fleet at 7.55-foot draft can be towed with the same resistance at 6 miles per hour as the conventional fleet has for 7 feet of draft. This corresponds to an increase of total displacement of 13 per cent. or 960 tons. This represents almost 7,000 barrels of gasoline, which is equivalent to a gain of 19 per cent.,

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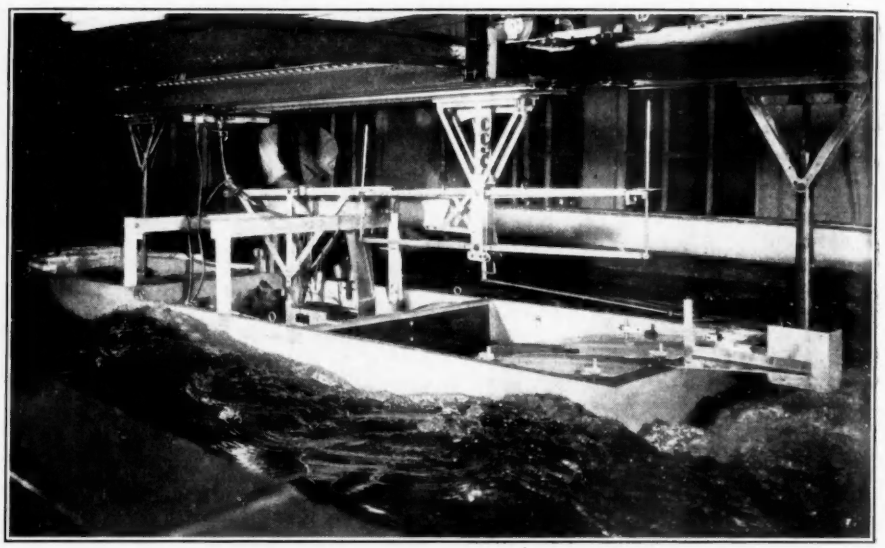


Fig. 1

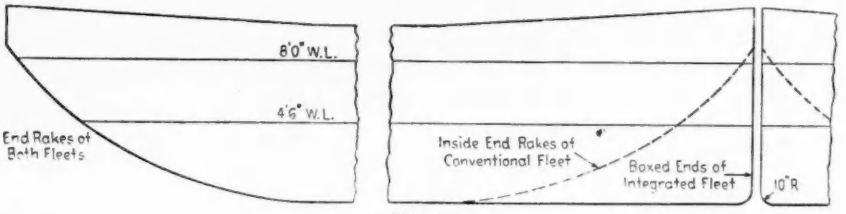


Fig. 2

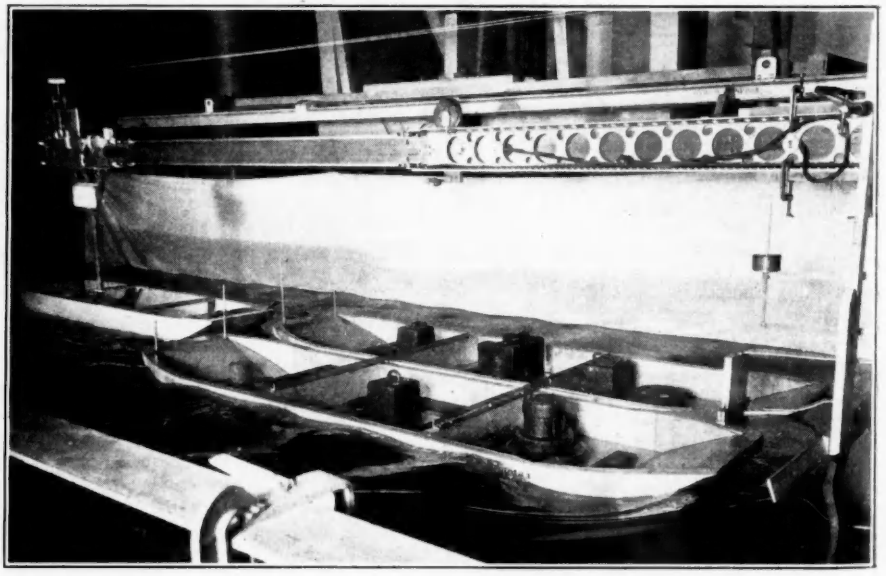


Fig. 3

Testing Integrated Barge Fleets—continued

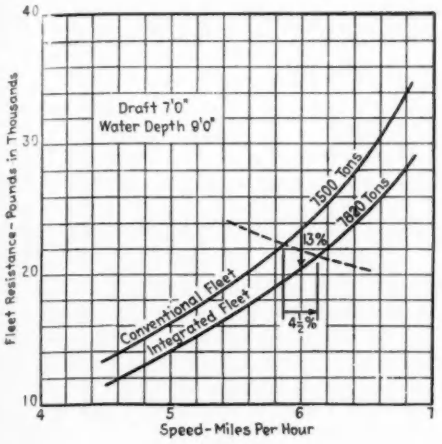


Fig. 4

taking out the weight of the empty barges.

It might be argued that 7 feet of draft in 9 feet of water is an unusually small bottom clearance. The savings will be somewhat reduced where the ratio of draft to water depth is smaller. On the other hand, much greater advantages are obtained if the extreme case of 8-foot draft in 9 feet of water occurs. The actual fleet is used at the designed draft of 8 feet in average depths of water somewhat over 9 feet. A total of 51,000 barrels of oil is carried, whereas the conventional fleet at the same draft would carry 48,000 barrels. The reduction in towing time for the whole trip is about 5 per cent. The complete set of resistance curves is given in Fig. 6, so that, if one desires, figures may be developed for a variety of cases.

Often engineering gains in one characteristic are obtained at the expense of some other desirable characteristic, so that a compromise is necessary. Here we have one of those rare cases of gain without cost; reduced resistance, increased capacity, and certainly no increase in cost of construction.

There will undoubtedly be some time lost in breaking up and fleeting at locks, due to the necessity of putting each barge in its proper place. This should not be much of a chore as the crew will soon work out an efficient system. Breaking up of the barges is not necessary in the Mississippi nor in the Ohio as far as Cincinnati, as none of the locks is under 600 feet. The fleet can go through in one locking and the towboat in the next.

Of course, a fleet of integrated barges will not be very useful for way-freight work. For petroleum transportation, however, where the barges can be uniformly loaded for a long trip, such equipment is ideally suited.

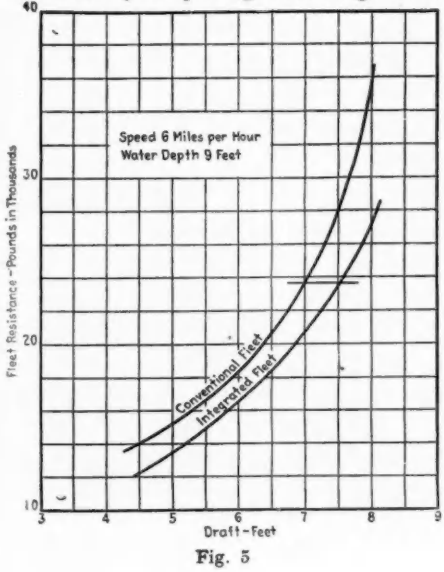


Fig. 5

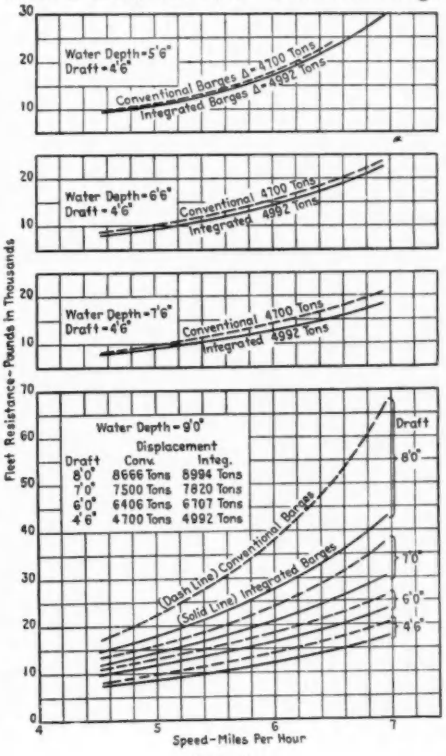


Fig. 6

Dustpan Dredger for use of Army Engineers

The Experimental Towing Tank of Stevens Institute of Technology is now preparing to start model tests of a dustpan type of hydraulic pipeline dredge intended for use by the Corps of Engineers, U.S. Army, in channel maintenance work on the Mississippi River. The preliminary study of the vessel has been completed in the Marine Division of the Philadelphia District, Corps of Engineers, but construction of the vessel is not immediately anticipated.

The dredger will be of all welded construction with hull dimensions of 256-ft. in length, 53-ft. wide and approximately 10-ft. deep. The vessel will be self-propelled by three 7½-ft. diameter propellers driven by reversing steam turbines of 1,200 h.p. each. The dredge pump will have a 36-in. diameter discharge and will be driven by a steam turbine of 4,000 h.p. Accommodation will be provided to subsist and quarter an operating crew of 99 officers and men.

The tests to be conducted by the Experimental Towing Tank will determine the resistance and propulsive characteristics of the hull when the vessel is operating individually at speeds from 6 to 12 miles per hour and when operating with its attendant fleet at speeds from 6 to 10 miles per hour. The normal attendant fleet consists of a 120-ft. by 30-ft. fuel oil supply barge, and seventeen 48-ft. pipeline pontoons used to discharge the material from the dredger to a selected location outside the river channel. The tests will be conducted under the varied arrangement of the dredger and attendant plant at simulated water depth and current conditions as are usually encountered in actual dredging operations.

It is anticipated that these tests will be shortly concluded, the results of which are to be furnished to the Marine Division, for use when completing the vessel's design.

It has been announced that the following publications have now been issued by the Experimental Towing Tank and are available for general distribution at the prices listed below.

Underwater Photographs of Flow Patterns (T.M. No. 86)

A description of a method which reveals the flow patterns about surface vessels by means of underwater photographs. The method holds promise of understanding flow conditions not easily obtained in any other fashion.

The Motion of Ships in the Initial Stages of Turning (T.M. No. 88)

A description of the initial stages of turning of ships. The memorandum puts more emphasis on the physical meaning of the quantities involved in the initial stages of turning than the usual analytical treatment.

Effect of Spray Strips on various Power-Boat Designs (T.M. No. 99)

A study of the effect of spray strips used on various power-boat designs tested at the Experimental Towing Tank. The purpose of these appendages is essentially to deflect water from the topsides of the hull.

An Underwater Photographic Method for determining Flow Lines of Ship Models (T.M. No. 101)

This memorandum is the result of further studies on methods for determining flow lines of a ship model. It involves the use of limp threads attached to the model surface, and an underwater photographic set-up with mirrors and flash lamps.

Resistance and Trim of Heavy Displacement Standard Series Ships (Stevens Models Nos. 578-583) (Report No. 279)

This report presents the results of resistance tests of six Standard Series models having higher displacement-length ratios in combination with higher speed-length ratios, than are reported in "The Speed and Power of Ships."

Notes of the Month

Development of N. Ireland Fishing Harbours.

It is reported that good progress is being made with the Northern Ireland Government's plans for the development of fishing harbours in Co. Down. A survey of Portavogie has been completed, and the survey of Kilkeel is also well alvanced, and it is hoped that the technical advisers to the Ministry of Commerce will submit their Report within a few weeks. The harbour improvements have been made necessary by the growth of the fishing fleets since the war. This has raised the value of the fishing industry to over £500,000 a year.

Grab Dredger for Jamaica.

An order for a grab dredger for the Caribbean Cement Company Ltd., Jamaica, British West Indies has been placed with the Goole Shipbuilding and Repairing Company Ltd. The vessel will be 125-ft. in length, 29-ft. in breadth, and have a draft of 12-ft., and is to have a carrying capacity of about 365 tons d.w. The propelling machinery, to be supplied by Crossley Bros. Ltd., Manchester, will consist of diesel engines developing 350 b.h.p. at 325 r.p.m. The vessel will be fitted with a large steam-driven grab crane by Priestman Bros. Ltd., Hull.

Panamanian Ships Inquiry.

The Committee set up by the International Labour Organisation to inquire into conditions of employment in ships flying the Panamanian flag held its second meeting in London on July 20 last, after which it visited a number of Panamanian ships at other United Kingdom ports. During its London meeting, the Committee discussed fresh information that had been received on the subject of the inquiry. The members of the Committee are Senator Herman Vos, Belgium (Government), Mr. A. G. Fennema, Netherlands (Employers), and Mr. A. Dalgleish, United Kingdom (Workers). They were accompanied by Mr. T. Bratt, of the Maritime Section of the International Labour Organisation.

Foreign Trade Zones for U.S.A.

The United States Government has approved the establishment of foreign-trade zones at the ports of Los Angeles and Seattle. This brings the number of free port areas in the U.S.A. up to five, the other three being at New York, New Orleans and San Francisco. The site of the new Los Angeles foreign-trade zone occupies a part of Municipal Pier No. 1, including Berth 60, and a section of Municipal Warehouse No. 1, located between the main channel and the east channel of Los Angeles—Long Beach harbour. The area reserved for the new zone at the Port of Seattle comprises warehouses and other buildings on the west margin of the east waterway, known as East Waterway Terminal. This waterway opens directly on to Elliott Bay, on Puget Sound.

New Dock for the Port of Glasgow.

A new dock is planned for the Clyde at a cost of £7,500,000, and it is expected that it will take about eight years to complete. The dock is to be built west of the King George V Dock at Shieldhall, Glasgow, and will supersede an earlier scheme which involved an expenditure of just over £6,000,000 on the reconstruction of Queen's Dock, higher up on the river. A decision to proceed with the construction of the new basin and its relative facilities was taken by the Clyde Navigation Trustees at a recent meeting in Glasgow, after consideration of a minute by the joint committee which has been dealing with the pressure on berthage facilities, as well as the trend of shipping and traffic requirements at the port. The joint committee agreed that berthage and traffic requirements, which exceeded those anticipated, precluded, as impracticable, the closing of Queen's Dock for reconstruction purposes. They recommended, therefore, that the Queen's Dock scheme be not proceeded with, except as to the widening of the entrance at a convenient time, but that, to meet the requirements of ocean shipping and trade, the trustees proceed with the construction of an additional basin west of King George V Dock.

Timber Deck Cargoes.

The Ministry of Transport draw the attention of shipowners and masters to cases where loss of timber deck cargo has been caused by faulty slip hooks. They point out that any deficiencies in slip hooks or other items of cargo-securing appliances might have very serious consequences, and remind masters of their responsibility to see that these appliances are of satisfactory type and are maintained in good order.

Working Agreement between West European Ports.

It has been announced that the ports of Belgium and Holland have joined with Hamburg, in a common working circle to create equal competitive conditions. The organisation which was established during negotiations between port representatives in The Hague, between July 9 and 12 last, will also help to fix rates for traffic, and it is hoped that other German ports will join in the agreement at an early date.

Bibliography on Soil Mechanics.

The Soil Mechanics and Foundations Committee of the Research Committee of the Institution of Civil Engineers has prepared a Bibliography on Soil Mechanics covering the years 1920 to 1946. The 3,000 entries have been classified by the Universal Decimal system and appear in both alphabetical order of Authors and in U.D.C. order. A copy of the Bibilography is available in the Institution Library. Publication of the Bibliography is being considered, and anyone who may be interested in obtaining a copy is asked to communicate with the Secretary of the Institution of Civil Engineers, Great George Street, London, S.W.1. Publication will depend on sufficient orders being received. The price is estimated at 3 guineas.

Proposed Improvements at the Port of Leith.

Improvements to the Leith docks and harbour were approved at a recent meeting of the Leith Dock Commission. During the four years ending May, 1953, approximately £414,000 will be spent on new works. This includes £155,000 for the completion of the deep water quays in the Western Harbour and the provision there of roads, rail and water and electricity supplies; £50,000 for lighthouses at the new entrance to the port; and £47,000 for an extension of the shed at the Albert Wharf, Outer Harbour, including the provision of two additional moveable electric cranes. The expenditure also includes £130,000 for improvements at berths 1, 2, 3 and 6 Edinburgh Dock, comprising additional railway lines, capstans, and ten moveable electric cranes, which will complete the modernisation of the facilities at the south side of the Edinburgh Dock commenced in 1946.

Port of London Improvements.

The Port of London Authority at a recent meeting approved a number of proposals for the improvement of port facilities which are estimated to involve an expenditure exceeding £1,000,000. The details are as follows: the construction of two twin-screw diesel-engined tugs for ship towage in the docks and three launch-type diesel-engined tugs for the towage of craft. The construction of a new road with a minimum width of 28-ft. at the rear of Nos. 22-26 Sheds, Tilbury Docks, and a spur road to replace Andrew's Road. These roads together with certain ancillary works are designed to afford improved access for the modern road transport now using Tilbury Docks. The reconstruction of Gallions Lower Entrance to the Royal Albert Dock, improving the capacity of the lock in relation to the draft of shipping, and the provision of new ram-operated lock gates. When reconstructed the lock will allow for the maximum draft of a ship using the lock for 2¼ hours near high water to be 31-ft. 3-in. at spring tides instead of 29-ft. 6-in. This work alone together with the provision of a pair of spare lock gates for the King George V Entrance Lock is estimated to cost over £750,000. The reinstatement following war damage and alterations to "T" and "V" warehouses, Royal Victoria Dock, including the installation of electric travelling hoists in each.

Pilferage Prevention Methods

Solution a World-Wide Problem

By JOSEPH McDONALD.

Last year, the United Kingdom lost £13 millions in thefts compared with a loss of only £2½ millions in 1938. This fact has been gathered from a report compiled by social science statisticians of Liverpool University after nearly 3 years of investigations.

Commenting on the problem of theft and pilferage in British ports, Mr. D. G. Scott, chairman of the Liverpool Underwriters' Association, had this to say: " There is no doubt that this handicap to our export trade makes it imperative for every effort to be made to mitigate the evil." In similar strain the annual report of the Liverpool Steam Ship Owners' Association draws attention to " a lamentable degree of pilferage from cargoes which is likely to continue so long as things are in short supply, and so long as offenders can too often rely on detection being visited with a trifling fine."

The Chief Constable of Birkenhead believes that there is a changing technique in dock pilferage, for in his annual report he observes: " In the past, while a fair number of occurrences indicated a tendency for dock worker gangs to make communal plunder of cargo, with individual share-outs of the proceeds, the latter was limited to the amount a man thought he could successfully conceal about his person. This type of pilfering has everything in common with the ' lone-hand ' class of thief, who, with the prospect of getting away with a bit, succumbs to the least temptation. He will always be with us, but these are matters of opportunity as opposed to planning. The planning is done by background men with ready markets for the quick disposal of bulk property."

After quoting all the effects of pilferage on such aspects as ship delays, delayed deliveries, cancelled orders and the further implications of financial losses to shipowners and insurance agencies, he laments the fact that among all the transport services concerned, from shipowners and stevedores down to hauliers and packers, " some firms are fully co-operative; with others co-operation is virtually impossible."

Comments and complaints are heard in all quarters; anti-pilferage committees are formed in all ports; but in the opinion of men who have spent a life-time on the docksides, nothing practical has been done or is being done anywhere in Britain to stop thieving except to re-apply worn-out methods of detection.

American Efforts at Prevention

Across the Atlantic, on the other hand, fresh efforts are being made to combat the evil. One American marine insurance firm has offered an annual trophy for the package adjudged to incorporate the most ingenious and effective hazards to prevent pilferage. The award will be known as the Harold Jackson Award, after Mr. Harold Jackson, president of W. H. McGee & Co., and president of the American Institute of Marine Underwriters. This initiative may well be copied by the New Institute of Packaging in Britain.

In an endeavour to reduce the enormous pilferage losses, totalling as much as £187,500,000 per annum, an American packaging committee composed of representatives of leading shipping companies has prepared a code of minimum standard packing. Another announcement from the Transportation and Communications Branch of the Office of International Trade, U.S. Department of Commerce foretells a campaign against inferior packing. More direct tactics were promised if the inherent educational policy " didn't take."

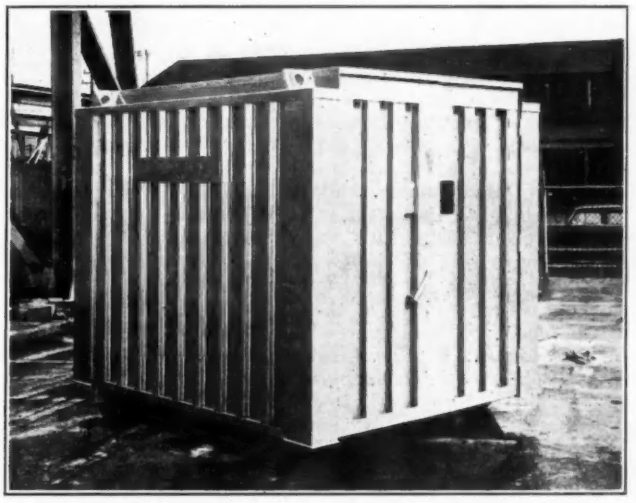
Interest in preventive measures has resulted in the formation of another committee by Mr. James Farrell, president of the Maritime Association of New York, and president of the Farrell Lines. The purpose of the committee is to study methods of improving packaging so as to minimise damage and pilferage. Consisting of 9 members, the committee represents shipping lines, exporters and underwriters.

" This committee will study the deficiencies which now exist in the packaging of an important percentage of export cargo," stated Mr. Farrell. " Unless export packaging methods are improved the Government may impose a compulsory packaging code."

" Millions of dollars worth of damage is caused to cargo every year by inadequate packing," he said, " and this has to be borne by shipping companies and underwriters."

Another example of American preventive measures is shown in the increasing use of cargo safes. Progressive American steamship companies, barge owners and carrying agencies are protecting their transhipments by the use of large welded steel shipping containers. Developed after long research by the Dravo Corporation of America for the safe transport of general cargo their use is proving so effective that these carriers are now expanding their container operations on a broad scale.

Virtually a safe deposit for merchandise, the new containers can be locked and sealed as a defence against pilferage. When properly packed in the containers, the goods are protected from ordinary damage hazards in addition to the advantage of avoiding pressure from other cargo. Users of the containers already enthusiastically affirm that damage losses have been negligible and pilferage practically eliminated.



Shipping Container manufactured by the Dravo Corporation.

Resembling a huge safe on 4 short, hinged legs, the frame consists of 4 corner posts formed by 9-in. by 9-in. box-shaped panels of 10 gauge steel linked together to form vertical reinforcing corrugations about 4-in. wide and 2-in. deep. The floor is of 16-gauge steel laid on reinforced 14-gauge corrugated steel. The double doors are made of the same material as the walls and provide an opening 53½-in. wide and 71-in. deep. Steel latches at the top and bottom of the doors are operated by either a lever equipped with a hasp for securing with padlock or seal, or by a special key. Being watertight the safe may be left in the open or carried on deck.

Many advantages are offered to shippers in addition to pillage protection. On one shipment of 12 Dravo containers in circulation between an east coast port and Puerto Rico cargo-handling costs were reduced to approximately one-fourth of the costs by traditional methods. Expenses of tiering and stowing were cut by about 90%; and dock charges, watching, checking and clerking costs were eliminated.

In another shipment 24 transformers were packed in open crates and stowed in a Transportainer and shipped to Puerto Rico as a single unit. Cost of packing these 24 units in solid wooden cases for export shipment would have been 272.40 dollars. Total labour and material cost of domestic packaging used for the Transportainer shipment was 68.64 dollars—a saving of 203.76 dollars.

7,800 lbs. of merchandise were loaded into a container in 4 hours by two men using a roller conveyor. On each container load, this cosmetic manufacturer saved (1), 120 dollars in export packaging materials; (2), 36 man hours of labour otherwise engaged to pack, nail, strap, weigh, stencil and handle 30 export cases; (3), 50% on marine insurance rates; and (4), his customer's goodwill.

Observations on other shipments disclosed that hatches of cargo ships could be cleared of cargo packed in cabinets at the rate of 12 containers an hour which, it is believed, could be improved by longer experience in handling. Records covering another shipment showed container loading time of 45 minutes from the hatch of a typical ship, compared with 3 or 4 hours necessary to unload a

Pilferage Prevention Methods—continued

comparable tonnage of loose individual packages. These time savings have arisen from the fact that a few units of from 2 to 6 tons were handled instead of a great many smaller units between 200 and 300 lbs. each.

It is claimed for these containers that freight transfer costs can be reduced not because less time is required to load or unload a ship, but because checking, sorting, and distribution are simplified: identical packages are handled by mechanical devices, and no delay is involved due to dunnaging needs of loose cargo. All these factors tend to improve turn-round time of shipping.

Before steel containers were employed, pilferage of cigarettes, tobacco, wines and spirits had become a perplexing problem difficult to control owing to the ease with which these small articles could be hidden on the body or passed out of dock gates by slipping them into recesses on vehicles leaving the dock enclosures.

Now when cigarette consignments arrive at the Grace Pier in New York the cases are unloaded from motor lorries and stacked immediately into steel containers. About 125 cartons, weighing approximately 32 lbs. each can be stowed in one of 277 cub. ft cabinets. Then the double doors are locked and the safes are stowed in the pier warehouse until wanted or taken at once aboard ship. The special construction of the cabinets simplifies handling, transfer and stowage operations, fork lift trucks and elevating platform machines being usually employed in the warehouses and on the piers.

Each trip, 30 containers holding a total of 60 tons of cigarettes are stowed in the trunk hatch of the Grace Line's cargo-passenger liners. Stacked 3 high they fill all the available space without crushing the cargo. At the port of discharge the containers are hoisted out of the holds and left on the dockside until delivery is arranged. Being water-tight they may be left uncovered in the open without damage from wind and rain.

The well-known firm of Lentheric, Incorporated, New York, now uses steel shipping containers for the transport of merchandise consigned from New York to San Juan, Puerto Rico. These cabinets are part of the customer service programme of Atlantic, Gulf and West Indian Steamship Lines. From records kept by A.G.W.I. Lines and Lentherics, the following advantages have been ascertained:

(1) Savings in man hours necessary for packing, marking, weighing and handling export shipments—approximately 36 hours each container.

(2) Savings in export packaging materials, including wooden boxes, waterproof paper, iron strapping, etc., estimated at 120 dollars each container.

(3) Reduction on breakages—75 per cent.

(4) Reduction in pilferage losses—100 per cent.

(5) Savings in marine insurance rates—50 per cent.

A.G.W.I. Lines pioneered the use of steel containers and has now more than 200 in constant use. The shipper pays no extra cost for using the safe except that a small demurrage fee is levied if a container remains in a shipper's possession for more than 48 hours. At the end of 1948 more than 1,000 cargo safes were being used by carriers and shipping companies.

Some outstanding comment on occupational thieving comes from America. Mr. Edward E. Conroy, executive vice-president of the Security Bureau, New York, reports a complete absence of waterfront pilferage during the 16 days' strike on New York docks in November last.

Mr. Conroy, whose organisation was established by shipping and insurance companies to counteract the pilferage evil said that his bureau had not received " even a single report of theft from the water side " during the strike period—November 10th to 27th. No similar report had been received from police, Customs and steamship protective officials.

During the strike Mr. Conroy noted that cargo was carefully stored where it could not be susceptible to theft. No dockers were present on the piers. The only personnel engaged were representatives of management, watchmen and skeleton crews.

Commenting on conditions, Mr. Conroy stated that " normally there is a constant flow of cargo on the piers, where thousands of dock workers are moving to and fro, having access to goods and merchandise. While there is activity on the piers, potential thieves have ample opportunities to remove cargo without creating suspicion. At week-ends and on holidays, when there is lessening of work, opportunities for theft decrease. During the strike period recently encountered, the problem practically vanished when police and watchmen remained alert.

This opinion of dockside dishonesty coincides with that of Merseyside observers. There is no doubt that all the temptations for large and small-scale thieving would disappear if the dockers would agree to mechanised methods of cargo-handling, the speedier handling removing the opportunity for pilferage. Of a total of 763 pilferage convictions in 1947, 24% were found to be genuine dockers—a fact which strengthens the contention that dock pillage has increased enormously during the past few years.

SITUATIONS VACANT.

PORT OF BRISTOL AUTHORITY.

Applications are invited for the post of **Marine and Dredging (Second) Assistant** to the Chief Engineer. The senior post of Marine and Dredging Assistant falls vacant in a few years time.

Training and experience in repairs and maintenance of dredgers and other harbour floating plant (hulls and machinery) is essential, and candidates should preferably have had experience in the carrying out of operations connected with dredging requirements.

Office experience, including the preparation of reports, estimates, etc., will be of advantage.

Salary applicable to post is £520 per annum rising by annual increments to £570, but commencing salary will be adjusted according to qualifications and experience of selected candidate. Position superannuable in accordance with provisions Local Government Superannuation Act, 1937, and successful candidate required to pass medical examination. Applicants must disclose whether related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications, stating age and other relative particulars and enclosing copies of recent testimonials, must reach the undersigned by 10 a.m. on Friday, the 26th August, 1949.

N. A. MATHESON,
Chief Engineer.

Port of Bristol Authority,
Avonmouth Docks, Bristol.

PORT OF MANCHESTER.
ENGINEERING APPOINTMENT.

The Manchester Ship Canal Company invites applications from suitable candidates to fill a junior position on its engineering staff.

Applicants should be between 25-35 years of age. They should be Corporate Members of the Institution of Civil Engineers and should preferably hold a degree in Engineering. They should have a good general experience on the design and construction of engineering works.

The position is on the permanent staff of the Company and is one which offers an interesting career to the successful applicant.

The salary offered will be in accordance with experience and qualifications. The candidate appointed will be required to become a member of the Company's Superannuation Scheme.

Applications, which should not in the first instance include testimonials, should be addressed, marked "Confidential," to the Chief Engineer, Manchester Ship Canal Company, Ship Canal House, King Street, Manchester 2, not later than 31st August, 1949.

PORT OF MANCHESTER.
APPOINTMENT OF RESIDENT ENGINEER.

The Manchester Ship Canal Company invites applications from suitable candidates to fill the position of Resident Engineer on the construction of a new oil dock, entrance lock and ancillary works.

The appointment will have a period of approximately three years.

Applicants should be Corporate Members of the Institution of Civil Engineers and not less than 40 years of age. They should have a wide experience in the construction of major harbour works.

Their knowledge of construction should include locks, mass concrete quay walls, wharves, building construction, drainage, large-scale excavation and dredging.

The position is an important one carrying a salary commensurate with the responsibilities entailed.

Applications, which should not in the first instance include testimonials, should be addressed, marked "Confidential," to the Chief Engineer, Manchester Ship Canal Company, Ship Canal House, King Street, Manchester 2, not later than 31st August, 1949.

Required at once, **Resident Engineer** for supervision of construction of large Berthing Dolphins in Persian Gulf area.

Qualifications required: Extensive experience of marine works, pile driving and reinforced concrete; must be a Corporate Member of The Institution of Civil Engineers or of Structural Engineers. Good pay and generous allowances, liberal leave terms. Apply by letter to Rendel, Palmer & Tritton, Consulting Engineers, 125, Victoria Street, Westminster, S.W.1, stating age and giving full particulars of qualifications and experience.

FOR SALE.

"GILL 30" AXIAL FLOW PUMP UNIT FOR SALE. Virtually unused. Capacity 3,600 cu. ft. of water per minute; with or without Paxman type 4RW diesel engine. Suitable for land drainage, sewage pumping, etc. Apply: Box No 106. "The Dock & Harbour Authority," 19, Harcourt Street, London, W.1.